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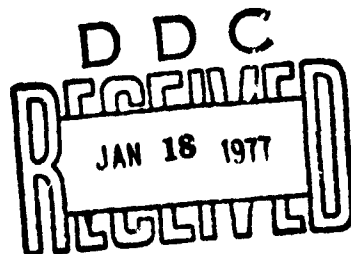
USER'S MANUAL FOR GENERALIZED ILSGLD-ILS
GLIDE SLOPE PERFORMANCE PREDICTION:
MULTIPATH SCATTERING

S. Morin
D. Newsom
M. Scotto

U.S. DEPARTMENT OF TRANSPORTATION
Transportation Systems Center
Kendall Square
Cambridge MA 02142



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16. Abstract This manual presents the computer program package for the generalized ILSGLD scattering model. The text includes a complete description of the program itself as well as a brief description of the ILS system and antenna patterns. The program listings are included as appendixes, and contain both input-generation programs and output-plotting programs. For a technical mathematical analysis of the system see the FAA report, "ILS Glide Slope Performance Prediction: Multipath Scattering." The present report is a partial revision of part II of report FAA-RD-74-157B. The revisions include the treatment of scattering from randomly oriented rectangular surfaces.			
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PREFACE

This document is a companion document to the Federal Aviation Administration report, "ILS Glide Slope Performance Prediction: Multipath Scattering," and contains the computer program for applying the model developed in the aforementioned report. The computational program may be used to predict the performance of new ILS glide slope systems, or modified existing systems. The manual contains a complete description of the glide slope system, the program listings, and step-by-step instructions for running the computer program.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures				Approximate Conversions from Metric Measures			
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	Multiply by	To Find
LENGTH				LENGTH			
in	inches	2.5	centimeters	mm	millimeters	0.04	inches
ft	feet	30	centimeters	cm	centimeters	0.4	inches
y	yards	0.9	meters	m	meters	3.3	feet
mi	miles	1.6	kilometers	km	kilometers	1.1	yards
						0.6	miles
AREA				AREA			
sq ft	square feet	0.9	square meters	sq cm	square centimeters	0.16	square inches
sq yd	square yards	0.8	square meters	sq m	square meters	1.2	square yards
sq mi	square miles	2.6	square kilometers	ha	hectares (10,000 m ²)	0.4	square miles
ac	acres	0.4	hectares			2.5	acres
MASS (weight)				MASS (weight)			
oz	ounces	28	grams	g	grams	0.035	ounces
lb	pounds	0.45	kilograms	kg	kilograms	2.2	pounds
	short tons (2,000 lb)	0.9	tonnes			1.1	short tons
VOLUME				VOLUME			
imp gal	imperial gallons	4.5	liters	ml	milliliters	0.03	fluid ounces
U.S. gal	U.S. gallons	3.8	liters	l	liters	1.06	quarts
qt	quarts	0.95	liters			0.26	gallons
p	pints	0.47	liters			26	cubic feet
c	cups	0.24	liters			1.3	cubic yards
fl oz	fluid ounces	29.6	milliliters				
teaspoon	teaspoons	5	milliliters				
tablespoon	tablespoons	15	milliliters				
fluid ounce	fluid ounces	30	milliliters				
cup	cups	240	milliliters				
quart	quarts	946	milliliters				
gallon	gallons	3,785	milliliters				
cubic foot	cubic feet	28.3	cubic meters				
cubic yard	cubic yards	0.76	cubic meters				
TEMPERATURE (exact)				TEMPERATURE (exact)			
F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature



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1. INTRODUCTION: DEFINITION OF INSTRUMENT LANDING SYSTEM

In a previous report,* a computer program (ILSGLD) was written to simulate certain terrain conditions which affect the glide slope portion of the Instrument Landing System (ILS). The ILSGLD model was developed to treat one-dimensional terrain variations. This report describes a generalized version of ILSGLD which treats two-dimensional ground plane variations, and which is able also to simulate the effects of scattering from planar, randomly oriented rectangular surfaces. A technical mathematical analysis of the system is described in a separate report.**

The ILS is used to provide signals for the safe navigation of landing aircraft during periods of low cloud cover and other conditions of restricted visual range. Separate systems are used to communicate vertical and horizontal information; the vertical system is called the "glide slope." This system operates by the transmission of an RF carrier, amplitude modulated by two audio frequencies, and beamed to approaching airborne receivers. In an instrumented aircraft, the glide slope receiver serves to demodulate the RF signal, amplify and isolate the corresponding audio signals and derive a signal to drive the ILS vertical display in the cockpit. The pilot, by reading the display, can determine if he is on course, above or below the glide path. These signals must be strong enough to cover a radius of 15 miles in front of the antenna.

* "ILS Glide Slope Performance Prediction," FAA RD 74-157B, Part II. 9/74.

** FAA, ILS Glide Slope Performance Prediction: Multipath Scattering, In Preparation.

The directional information is determined by the relative strengths of the transmitted sideband signals. The audio frequency modulations, which are fixed at 90 and 150 Hz, are radiated in different angular patterns with respect to the intended glidepath. The "course" is defined as the locus of points where the amplitudes of the two modulations are equal. The display of a difference of the amplitudes (90 and 150 Hz) of the sidebands is referred to as the Course Deviation Indication. Thus, the CDI is the pilot's indication as to what his deviation is relative to the glidepath. The CDI is measured in microamperes. The actual course generated by any particular ILS installation will deviate from the ideal because of irregularities in the terrain. The deviation of the CDI caused by these irregularities, from the ideal receiver reading at that point in space (e.g., on the glidepath a CDI reading other than 0) is the derogation effect.

The glide slope system transmits an asymmetrical pattern by beaming a "carrier plus sideband" pattern and a "sideband only" pattern, the composite of which gives the desired effect.

2. ANTENNA PATTERNS

The proper angular variation of the transmitted 90 and 150 Hz modulation is achieved by the radiation of the two independent sideband patterns by the transmitting antenna. One pattern, the "carrier plus sideband" (C+S) signal, is radiated in a symmetrical pattern; the other pattern, the "sideband-only" (SO) signal, is radiated in an "anti-symmetrical" pattern relative to the prescribed glide angle (see Figure 1).

The C+S signal is composed of a carrier wave and paired sideband waves at 90 and 150 Hz. The sideband amplitudes are equal and represent a 40 percent modulation of the carrier wave (or a "depth of modulation" of 0.4) at both frequencies. The SO wave is a carrier wave that is equally modulated at 90 and 150 Hz to the extent that it retains no pure carrier component.

The spatial modulation pattern obtained by combining the symmetrical C+S pattern with the "anti-symmetrical" SO pattern is illustrated in Figure 1. At a given receiver point the total signal is the C+S carrier plus the combined sideband amplitudes of the C+S and SO patterns. The sideband amplitudes are phased so that above the glide path the 90 Hz amplitudes add and the 150 Hz amplitudes subtract, while below the glide path, the 90 Hz amplitudes subtract and the 150 Hz amplitudes add.

Any angular deviation of the airplane's receiver from the correct course results in a "Difference in Depth of Modulation" (DDM) between the 150 and 90 Hz signals. Since the strength of C+S and SO signals fall off at the same rate with distance from the transmitting antenna, the DDM is independent of range.

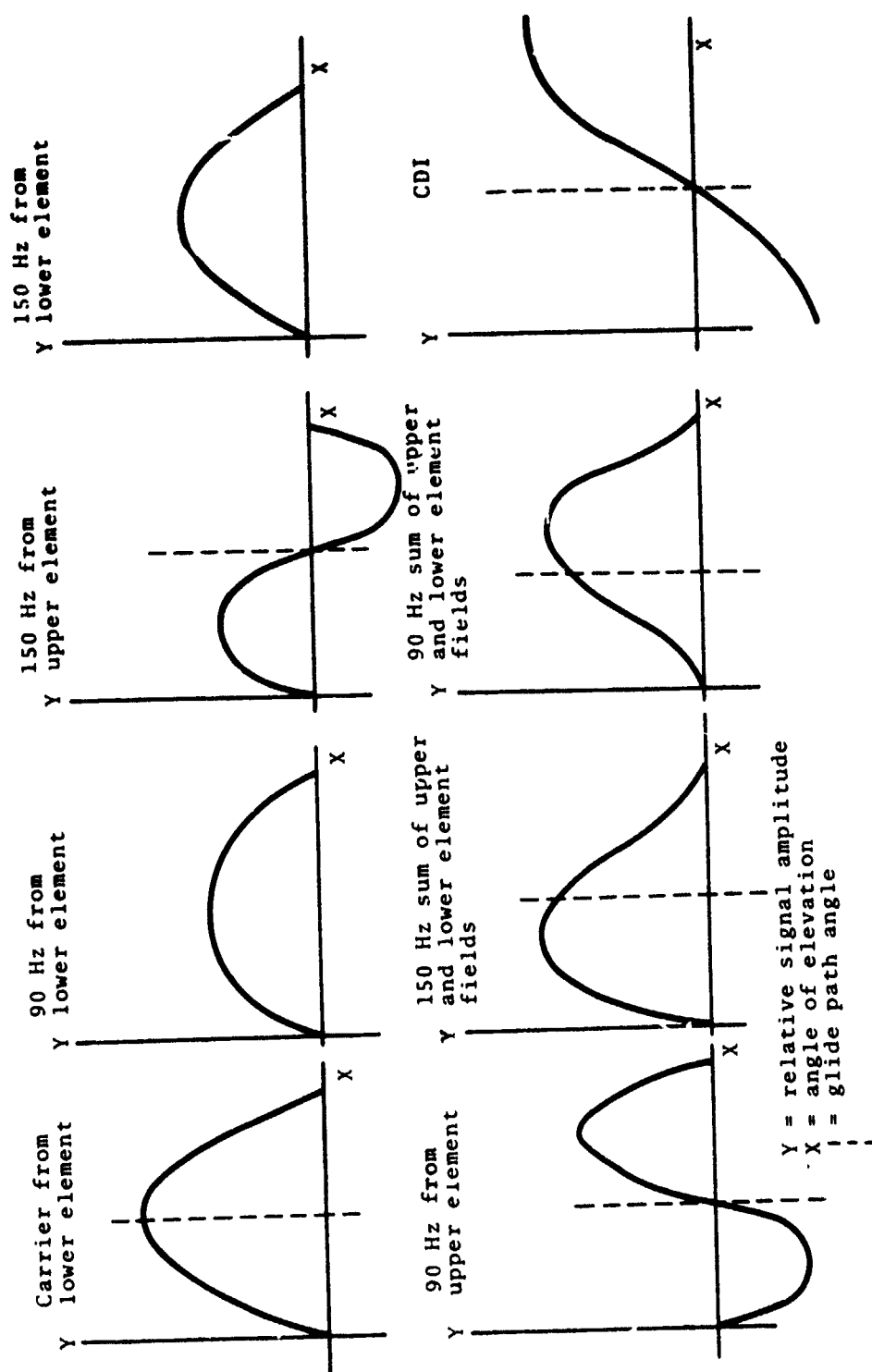


FIGURE 1. ANTENNA PATTERNS FOR NULL REFERENCE ANTENNA

The antenna patterns are generated by using arrays of one or more elements in combination with the ground as reflector. The effect of an ideal ground plane on a single element is as though there was an "image" element located below the ground and radiating equal power to the real element but with opposite phase. In a glide slope array there will be two or more elements radiating different signals to give the desired combined antenna pattern. (Note that this means that a glide slope array is defined by giving, for each element, its location and complex amplitude of the carrier and sidebands.) However, the real ground is not an ideal plane. This has the effect of distorting the element patterns and results in a derogation of the glide slope system performance.

The extended glideslope derogation simulation package consists of five programs. They are:

FMAKE.F4	Used to generate input files for the simulation.
ILSVEN.F4	Simulates the one-dimensional-variation ground. Takes input prepared by FMAKE. Outputs the complex field intensities at the various receiver locations.
MOLE.F4	Simulates the scattering from a rectangular planar surface with arbitrary orientation. Takes as input the data output from ILSVEN. Outputs a new set of fields.
GLDCDI.F4	Simulates the effects of the receiver, including CDI determination and dynamic smoothing from the instrumentation.
GLDPLT.F4	Produces graphical presentations of the CDI results from the simulation. Takes as input the data file

output from GLDCDI. Outputs graphs of various forms as determined by the user.

The inputs and operation of these programs will be given in the following sections.

The basic procedure is to prepare the input with FMAKE. The ground effects are determined by running ILSVEN. The output is a data file containing the antenna descriptors, the receiver locations and the complex field intensities for the carrier and sidebands. If desired GLDCDI may be run at this point to produce the CDI's that would be produced by this ground configuration, antenna system, and flight path. If additional scatterers are involved such as buildings or hills, they may be represented as rectangular surfaces and the derogation effects added with MOLE. MOLE may be used as often as needed to include any number of scattering surfaces. After all surfaces have been included GLDCDI is run to generate the CDI file for input to the graphing program. GLDPLT is then run to generate the graphs required.

3. GROUND EFFECT SIMULATION WITH ILSVEN

The ILSVEN program simulates the effects of a non-planar ground on the glide slope antenna system.

The program uses a ground description, an antenna description and a set of spatial coordinates for the receiver locations as input. The program calculates the outputs for each receiver location, the complex values of the fields for carrier and sidebands that would be received at that location. This represents the summation of the direct fields from each antenna element and the fields from each antenna element scattered from the parts of the ground "plane." Additionally the fields that would be produced by an ideal ground plane are included. This allows comparison with flights that do not have a simple ideal CDI along the flight path, for example, flights at right angles to the glide path such as are used to determine the course width.

The ILSVEN simulation makes certain simplifying assumptions. They include:

- a. Perfectly reflecting ground surface
- b. Far-field scattering--all scattering from points on the ground surface is assumed independent of all other points; thus multiple reflections and near-field interactions are ignored
- c. Noise-free environment
- d. Relative field strengths--the absolute field strengths involved are not calculated. Thus, while the CDI's can be calculated in microamperes, the absolute electric field intensities are not ascertained,

e. Geometric shadowing--the shadowing of one portion of the ground on another is done by straight ray approximations assuming a total cutoff with no diffraction, and

f. Antenna elements are assumed to be simple dipoles.

3.1 METHOD OF SIMULATION

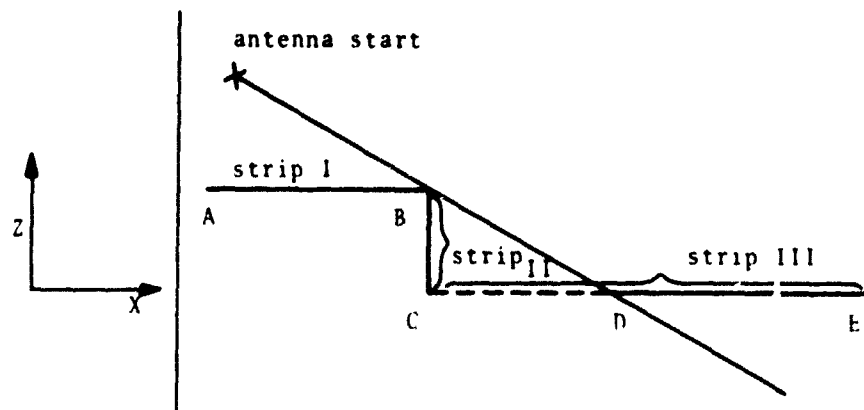
An antenna element is described by giving its x , y - and z -coordinates and the complex amplitudes of its radiated amplitude at the three frequencies (carrier, 150 and 90 Hz sidebands). The ground is broken up into strips; these strips have an infinite width and a finite length. The infinite extent is parallel to the y -axis, that is at a right angle to the runway centerline. Thus, a ground strip is described by giving the x and z -coordinates of the leading and trailing edges of the strip. A receiver location is described by giving its time, x -, y - and z -coordinates.

The basic part of the simulation consists of calculating the field at a receiver location. This field is caused by the power radiated from an element and reflected from a strip. The receiver field can be expressed as a complex gain factor times the radiated antenna field. This gain factor is expressed as a double integral over the strip. The integration along the infinite extent (y axis direction) was approximated by using the stationary phase method. The resulting single integral is solved by a modified trapezoid rule. The trapezoid rule is used with the spacing between sample points adjusted for the derivative of the integrand.

Thus, for a given receiver location, the program takes an antenna element and calculates the "gain factor" for each ground strip, multiplies by the radiated power, and sums the three complex

field intensities for all ground strips. The direct field of the element at the receiver is then added. This process is repeated for all elements, giving the total field at the receiver. For comparison purposes the fields resulting from an ideal ground plane are calculated. The location of the receiver (x -, y -, z - and t coordinates) are output along with the six complex field intensity numbers. This is then repeated for each receiver location in the input file.

If the terrain is sufficiently irregular, part of the energy radiated toward a point on the ground may be intercepted by another piece of the ground closer to the antenna. This shadowing is complex including, as it does, diffraction as well as reflection. This is approximated in the simulation by using ray optics; that is, the shadow is assumed to have no diffraction at the edges and a zero field amplitude inside of the shadow. The program does this by assuming the ground is continuous; i.e., the far edge of one strip is the near edge of the next, and keeping track of the "furthest" (in angular sense) edge. If part (or all) of the next strip is "below" that edge, then that part (or all) will not be included in the trapezoid integration. For example in the sketch below:



all of strip I, none of strip II and that part of strip III between D and E will be included in the integration.

For the receiver antenna a "semi" directional antenna is assumed; that is, only the incident fields from the front half-sphere around the receiver are included. This is as though an omni-directional antenna was used but blocked by the fuselage from receiving signals from the direction of the tail. This is done in the program by stopping the summation of fields over the ground strips at a point directly below the receiver.

The back half-plane is assumed to be an ideal flat horizontal reflector of infinite extent. The field from this is included by adding the "gain factor" for this as an initial strip to that calculated by integrating over the "real" strips.

3.2 OPERATION

ILSVEN assumes the ground description is a file called GRND.DAT, and that the receiver locations are in a file called PATH.DAT. The user starts the program and then inputs the name of the file containing the antenna description. The simulation will be run, and the output will be found in file STRIP.DAT.

4. ADDITION OF SCATTERERS WITH MOLE

MOLE is used to include the derogation effects of finite scatterers. This would include sides of buildings and other man-made objects composed of flat rectangular surfaces. In addition portions of the ground surface such as hills can be simulated if they may be represented by rectangular pieces. The program takes as input a file generated by ILSVEN. This contains the antenna and flight path descriptions along with the complex fields scattered from the ground for both the non-planar ground simulated and for the ideal ground case. The program adds to these fields the fields resulting from scattering from the piece being simulated and outputs a new data file containing the input data with revised values for the complex fields. The output file being in the same format as the input file allows this output to be used as the input for another run of the MOLE program. This permits the user to continue to add in the effects of as many scatterers as desired.

The simulation makes certain simplifying assumptions. They include those explained for ILSVEN. In addition, the ground surface for the MOLE simulation is assumed to be the ideal flat horizontal ground plane. Thus the multiple reflections from the antenna element to ground to scatterer, and from scatterer to ground to receiver, are done using a simple ground plane.

To operate the program the user will have previously run ILSVEN to simulate the terrain involved. When MOLE is run, the program will request:

INPUT FILE NAME:

The user types in the name of the file output from ILSVEN. This is initially named STRIP.DAT, but may have been renamed by the user if there is more than one simulation to be done.

The program will then request:

OUTPUT FILE NAME:

The user then types in the name to be given to the file to be output from MOLE. This file will contain the modified filed values in addition to the antenna and flight path data from the input.

The program will then read in the piece description data from unit 20. (Normally, it is a disk file FOR20.DAT.) These data are in free-field general FORTRAN format (3G). The data consist of the x-, y-, and z-coordinates for the four corners of the rectangle, one set of coordinates per line. The corners are described in the order that they would be scanned in traveling around the perimeter of the rectangle in a clockwise direction. In this sense, the rectangle is assumed to be facing the user. For example, the coordinates:

0.0.0,
1.0.0,
1.0.1, and
0.0.1,

describe a square, one foot on a side, situated on the centerline of the runway oriented with one side on the centerline on the ground, and one side vertical at the origin. The "front" of the square is facing in the positive y-direction. See figure example (Figure 2).

The program will then execute the simulation, output the new file, and terminate. Multiple runs, scatterers and input cases may be set up using the usual batch control features.

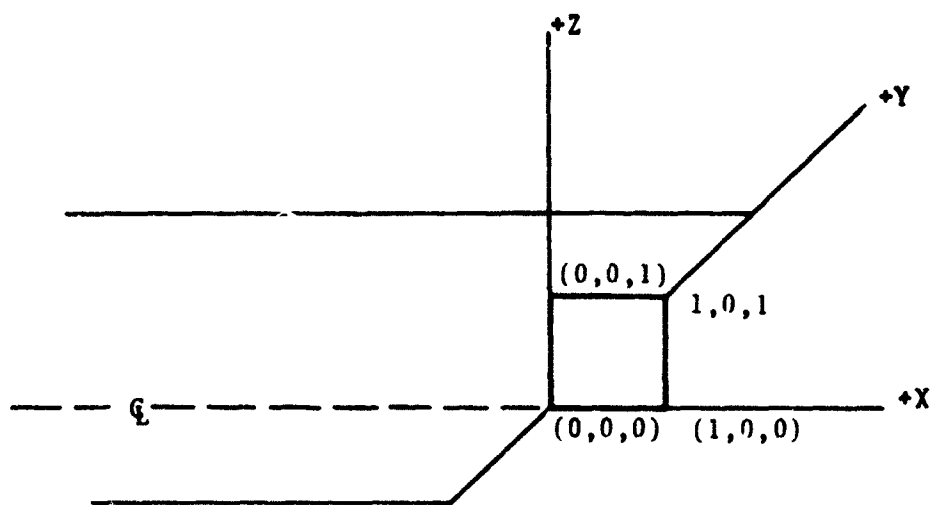


FIGURE 2. REPRESENTATION OF SQUARE SCATTERER

5. CDI DETERMINATION USING GLDCDI

The output files from ILSVEN and MOLE contain the complex field intensities for the carrier and sidebands for the cases simulated. For analysis purposes the user would usually wish to see the CDI's produced. The difference between these and the correct CDI's is the derogation that would affect the pilot in the case being studied. This CDI generation is done by GLDCDI. The program will calculate the CDI for both the static case and for a dynamic case using the smoothing time constant input in FMAKE.

To operate the program the user runs GLDCDI. The program will request:

INPUT FILE NAME:

The user then types in the name of the file (generated by ILSVEN or MOLE). The program will then request:

OUTPUT FILE NAME:

The user then types in the name of the file to be used for the output file. The program will then execute and terminate. The output file contains the CDI's static and dynamic for both the simulation and the ideal ground case. The various CDI's may be graphic using GLDPLT.

6. FMAKE PROGRAM DESCRIPTION

FMAKE is a file generation program used to create input files for ILSVEN. It is designed to be used interactively. The user starts by running the program. The program will respond by typing:

INPUT SWITCH:

The user then types in a single character switch, followed by a <CR>, for the file he wishes to generate. The program will then respond with a request for the input required for that file. If a blank is used as the input switch the program will terminate. If any character other than those explained below are used, an error message will be given. After each file is generated, the program will return to the switch input point thus allowing the user to generate the data files for many simulation runs in one sitting.

(N.B. All units are in feet unless otherwise stated)

6.1 SWITCH: Y

For this switch (Y), the program will type:

INPUT YO, LAMBDA:

The user then inputs in free field format the y-offset (i.e., the y-coordinate) of the antenna elements and the wavelength of the carrier, followed by a <CR>. The y-offset is the distance from the base of the antenna to the centerline of the runway. As this information is required for both the antenna description and the flight path, it is input with a separate switch to avoid repetition.

6.2 SWITCH: G

This switch (G) is used to input the ground description. The program will respond with:

INPUT GROUND FILE NAME:

The user then inputs a <five(5) character name for the ground description file, followed by a <CR>. ILSGLD requires the ground file to be called GRND.DAT. (The .DAT extension is a system default.) FMAKE allows the user to generate several ground files with different names at one sitting. Then by using system renaming commands, a single batch job may be set up that will run many simulations without further user interactions.

The program will then type:

INPUT GROUND LABEL.

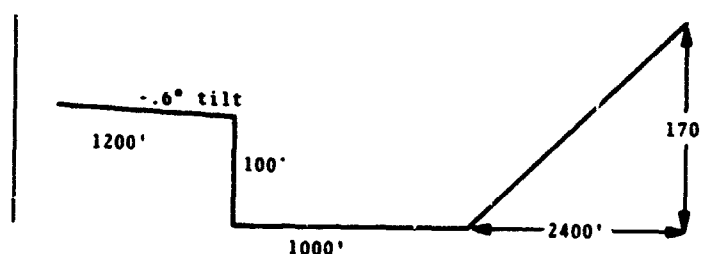
The user then inputs up to 40 characters to be used as a label for this ground description. The label is carried in the ground description file and will be placed in the output file by ILSGLD. It allows the GLDPLT program to label the plots with the ground description. This is necessary if a batch job generates plots from more than one simulation.

The program will then type:

INPUT GROUND SEGMENTS. STARTING FROM ANTENNA GIVE CONSECUTIVELY EITHER X AND Z INCREMENTS OR THE LENGTH AND ANGLE FROM HORIZONTAL IN DEGREES, SEPARATED BY A ZERO. HIT CARRIAGE RETURN FOR END OF DATA, OR IF THERE ARE NO MORE STRIPS.

The user inputs ground strip end points in either Cartesian or polar increments using two or three fields respectively. They are input in floating free field format followed by a <CR>. The first point is taken relative to the origin and is the near edge of the closest strip to the antenna. The second point is the far edge of the first strip and the near edge of the second strip.

This second point is relative to the first. This will continue for additional strips until a <CR> is hit with no data, at which point the program will return to the switch input. For example to input this profile:



The input would be

0.,0.

1200., 0., -.6

0., -100.

2400., 170.

There is a maximum of 20 strips allowed in both FMAKE and ILSGLD. This is determined by array sizes and could be changed if desired.

6.3 SWITCH: P

This is used to generate a flight path file. The program will respond:

INPUT FLIGHT PATH FILE NAME:

The user then inputs a five (5) character file name (the name must be exactly 5 characters). ILSGLD requires the flight path to be in

a file called PATH.DAT (for explanation of multiple files see SWITCH:G). The program will then type:

INPUT FLIGHT PATH TITLE:

The user then inputs a title, using up to 40 characters, for the flight path. This is used as a label on the plots output by GLDPLT. The program will then type:

INPUT FLIGHT PATH TYPE:

The user has a choice of two flight path types, linear or hyperbolic. For a linear flight path, type a <CR>; for a hyperbolic path type a 'G' followed by a <CR>. When it is a linear flight the program will respond:

INPUT X0, Y0, Z0:

The user then inputs the x-, y-, and z-coordinates of the first receiver point in free field floating point format followed by a <CR>. The program will respond:

INPUT XF, YF, ZF:

The user then inputs the final receiver location in the same way. The program then types:

INPUT # OF POINTS, VELOCITY, TIME CONSTANT:

The user then inputs the total number of receiver locations desired in integer free field format, followed by the velocity of the aircraft in feet/sec. in floating point free field and the time constant in seconds (usually 0.4) used for the "inertia" of the receiver in dynamic simulation. The program will then generate the data file and return to the SWITCH POINT.

The actual ideal surface of zero CDI is a hyperboloid of two sheets whose axis of rotation is parallel to the z-axis and passes through the antenna. For comparison purposes it is convenient to

have the aircraft travel along this surface and see how the real CDI deviated from 0. If the glide path is used for linear flight in the near field (between threshold and antenna) large CDI's will occur because of the hyperbolic shape. The program will allow the user to generate a hyperbola which is the intersection of the 0 CDI surface and the plane containing the runway centerline parallel to the z-axis. To do this the user types a 'G' for the flight path type. The program will respond:

INPUT XO, XF, H:

The user inputs these in floating point free field format followed by a <CR>. XO is the x-coordinate of the initial receiver point (YO is zero and ZO is specified by the hyperboloid), XF is the x-coordinate of the final receiver point. H is the height of the main carrier element in the antenna array. The program will then respond:

INPUT # OF POINTS, VELOCITY, TIME CONSTANT

These are input as above. The program will generate the file and return to the switch point.

6.4 SWITCH: A

This switch is used to generate the antenna description file. The program will respond:

INPUT ANTENNA FILE NAME:

The user inputs the 5 character file name. The program will type:

INPUT ANTENNA DESCRIPTION:

The user inputs a <40 character antenna description to be used as a plot label. The program will then type:

INPUT ELEMENT VALUES:

The user then types in, in free field floating format, a maximum of 8 fields followed by a <CR>. The fields have the following use:

<u>field #</u>	<u>use</u>
1	x-coordinate of element (usually 0)
2	z-coordinate of element (height)
3	real amplitude of carrier
4	imaginary amplitude of carrier
5	real amplitude of 150 Hz side band
6	imaginary amplitude of 150 Hz side band
7	real amplitude of 90 Hz side band
8	imaginary amplitude of 90 Hz side band

This element inputting is repeated for each element. After the last element is input an extra carriage return is typed. No y-coordinate is input for the elements. This is because nominally all the elements have the same y offset (the value input as Y0 under switch:Y). However, a small offset correction is applied for near field correction. An explanation of this correction may be found in part I (see discussion preceeding Eq. (33)). This is automatically done by the program. As the first element input is assumed to have the correct offset, it will always have a value of Y0. Thus the main carrier element should be input first, for example, a null reference antenna was input as follows:

INPUT SWITCH: Y

INPUT Y0, LAMBDA: 300., 3.

7. GLDPLT PROGRAM DESCRIPTION

GLDPLT is a plotting output program to graph the CDI information from GLDCDI. The user runs GLDPLT which then types:

INPUT FILE NAME AND AXIS TYPE:

The user then types in a 5 character (left-justified and blank filled to 5 characters) and two integer fields in free field format. The first integer is the switch for x-axis type and the second integer is the switch for the y-axis. The y-switch has two values, 1 and 2, the x-switch has three 1, 2, and 3; any other values will terminate the program.

The switches have the following use:

y-switch=1 this plots the static CDI values

y-switch=2 this plots the dynamic CDI values

x switch=1 this uses the altitude angle, in degrees
measured from the origin of the receiver
point as x-coordinate

x-switch=2 this uses the x-coordinate of the receiver
as the x-axis

x-switch=3 uses the time in seconds, at the receiver
point, as the x-coordinate.

After the input, a plot is generated and the program returns to the input and asks for the data for the next plot. The user can give the same file name to plot the data differently, or a new file name can be given. This would be done when multiple runs were done before plotting, the output file from each simulation run carrying its own name.

INPUT SWITCH: A

INPUT ANTENNA FILE NAME: NULL

INPUT ANTENNA DESCRIPTION

NULL REFERENCE ANTENNA

INPUT ELEMENT VALUES

0., 15., 1., 0., .4, 0., .4, 0.

0., 30., 0., 0., -.12, 0., .12, 0.

APPENDIX A ILSVEN

ILBYEN.F4 F48 V27(368) 22-APR-76 11:04

```

1      DIMENSION ILABL(8)
2      DIMENSION IPTDAT(33)
3      COMMON /PLKT/ NRP,RXHN,RXNY,RXF,RXLY,RVHN,RVNY,RVFT,RVLY,
4      1RZHN,RZMX,RZFT,RZLY,RTHN,RTMX,RTFT,RTLY,
5      2AIMN,AIMX,AIFT,AILT,ARMN,ARMX,ARFT,ARLY,
6      3ADIN,ADIN,ADIF,ADIL,
7      4ADRN,ADRX,ADRF,ADRL
8      EQUIVALENCE (IPTDAT(1),NRP)
9      IMPLICIT COMPLEX (C)
10     DIMENSION X(20),Y(20),Z(20)
11     DIMENSION CF1(20),CF2(20),CF3(20)
12     IMPLICIT DOUBLE PRECISION (D)
13     COMMON /REC/RX,RV,RZ,RT,NSIZE
14     REAL LAMBDA
15     COMMON /GROUND/ K,X1(20),Z1(20),X2(0/20),Z2(0/20),IEL
16     COMMON /ANT/AX,AY,AZ,LAMBDA,DAK,DPI
17     COMMON /VAL/ MR,MI
18
19     C      THIS VALUE OF TWO PI IS INITIALIZED THIS WAY TO AVOID USING
20     C BLOCK DATA
21     C      DPI=6.2831853071795864769
22
23     C      THIS OPENS THE OUTPUT FILE
24     C      CALL OFILE(1,'STRIP')
25
26     C      THIS SUBROUTINE OPENS THE FLIGHT PATH FILE AND RETURNS WITH
27     C THE FLIGHT PATH PLOT LABEL (ILABL) AND TIME CONSTANT (TAU)
28     C THE FILE WAS SET UP WITH JOVRAX SO THIS SUBROUTINE AND INPUT ARE
29     C USED TO FACILITATE MODIFICATIONS
30     C      CALL IF(ILABL,TAU)
31     1000 FORMAT(8A9,F)
32     WRITE(1,1000) ILABL,TAU
33
34     C      THIS SECTION INITIALIZES SOME CONSTANTS
35     C      NRP=0
36
37     C      THIS SECTION INPUTS THE GROUND STRIPS DESCRIPTIONS
38     C      CALL IFILE(20,'GRND')
39     READ(20,1000) ILABL
40     WRITE(1,1000) ILABL
41     READ(20) K,X1,Z1,X2,Z2
42     CALL RELEAD (20)
43
44     C      THIS SECTION INPUTS THE ANTENNA FILE NAME TO BEUSED
45     C AND THEN INPUTS THE ANTENNA ELEMENT DESCRIPTIONS
46     WRITE(5,2001)
47     2001 FORMAT(' INPUT ANTENNA FILE NAME:',8)
48     READ(5,2000) ILBL
49     2000 FORMAT(A9)
50     CALL IFILE(20,ILBL)
51     READ(20,1000) ILABL
52     WRITE(1,1000) ILABL
53     READ(20) LAMBDA,NEL,(X(I),Y(I),Z(I),CF1(I),CF2(I),CF3(I),I=1,NEL)

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94      WR1TF(1) LAMBDA,NEL,(X(1),Y(1),Z(1),CF1(1),CF2(1),CF3(1),I=1,NEL)
95      CALL RELEAS (20)
96      SORT2L=1./SORT(2.*LAMBDA)
97      TEMP2=LAMBDA
98      DAK=DP1/DBLE(LAMBDA)
99      SAK=SNGL(DAK)
100     C
101     C      THIS IS THE MAIN LOOP FOR THE SIMULATION, THE RECEIVER
102     C LOCATION IS READ IN BY INPUT, THE DATA IS IN COMMON 'REC'
103     C THE INPUT BEING DONE BY JOVRAX, IF THERE ARE NO MORE RECEIVER
104     C POINTS THE SUBROUTINE RETURNS TO 200.
105     C      201 CALL INPUT(S200)
106     C
107     C      THIS SECTION INITIALIZES THE COMPLEX AMPLITUDES FOR
108     C THE RECEIVED FIELD AS FOLLOWS:
109     C      CFR1 CARRIER WITH 'REAL' GROUND
110     C      CFR2 150 MHZ SIDEBAND WITH 'REAL' GROUND
111     C      CFR3 90MHZ SIDEBAND WITH 'REAL' GROUND
112     C      CFR1 CARRIER WITH 'IDEAL' FLAT GROUND PLANE
113     C      CFR2 150MHZ WITH 'IDEAL' GROUND
114     C      CFR3 90 MHZ WITH 'IDEAL' GROUND
115     C      CFR1=(0.,0.)
116     C      CFR2=(0.,0.)
117     C      CFR3=(0.,0.)
118     C      CFR1=(0.,0.)
119     C      CFR2=(0.,0.)
120     C      CFR3=(0.,0.)
121     C      R2=SQRT(RX*RX+RZ*RZ)
122     C
123     C      THIS LOOP IS OVER THE ELEMENTS OF THE ANTENNA
124     C THE COMPLEX FIELDS ARE SUMMED IN CFR1,CFR2 ETC.
125     C      DO 3 IEL=1,NEL
126     C
127     C      THESE ARE THE LOCATION COORDINATES OF THE ANTENNA ELEMENTS
128     C AND CONSTANTS USED IN THE STRIP INTEGRATION
129     C      AX=X(IEL)
130     C      AY=Y(IEL)
131     C      AZ=Z(IEL)
132     C      DELX=RX-AX
133     C      DELY=RY-AY
134     C      DELZ=RZ-AZ
135     C      DR=DSQRT(DELX*DELX+DELY*DELY+DELZ*DELZ)
136     C      R=SNGL(DR)
137     C      DR=D*DAK
138     C      IL=DR/DP1
139     C
140     C      THIS SECTION INITIALIZES HR AND HI TO INCLUDE THE
141     C SEMI-INFINITE REAR GROUND PLANE
142     C      TEMP2=DR*DBLE(FLOAT(IL))*DP1
143     C      TEMP2=48
144     C      F1=SQRT(TEMP*TEMP+AY*AY)
145     C      F2=-RX*TEMP/(R2*F1)
146     C      TC=SQRT(1.+AY*AY/(TEMP*TEMP))

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107      TD=TP*AZ
108      R1=R2*TC
109      S=SQRT((1./R2+1./AZ)/(TC+TC*TC))
110      G=RX/(TD+TD*R1+R1*S)
111      TEMP=SAK*F1
112      SF=SIN(TEMP)
113      FC=COS(TEMP)
114      TEMP=AZ*G/DAK/F2
115      C
116      C      HR AND MI ARE THE REAL AND IMAGINARY PARTS OF THE COMPLEX
117      C 'GAIN' FACTOR OF THE GROUND SURFACE SCATTERING TO THE RECEIVER
118      C LOCATION
119      HR=TEMP*(SF*FC/(DAK*TD))
120      MI=TEMP*(FC-SF/(DAK*TD))
121      C
122      C      THIS SUBROUTINE SUMS THE 'GAIN' FACTOR FOR EACH STRIP OF
123      C THE GROUND SURFACE
124      CALL SCAT
125      C
126      C      THIS SECTION INCLUDES THE EFFECT OF THE DIRECT RADIATION FROM
127      C THE ANTENNA ELEMENT AT THE RECEIVER
128      HR=HR+SORT2L
129      MI=MI+SORT2L
130      TEMP=DELX/(R+R)
131      SF=SIN(TEMP2)
132      FC=COS(TEMP2)
133      C
134      C      CTEMP IS THE COMPLEX GAIN FACTOR INCLUDING ALL RADIATION FROM
135      C THIS ELEMENT
136      CTEMP=CMPLX(-TEMP*SF+HR-MI,TEMP*FC+HR+MI)*.5/LAMBDA
137      C
138      C      THIS SECTION ACCUMULATES THE FIELDS OF THE VARIOUS FREQUENCIES
139      CFS1=CFS1+CTEMP*CF1(IPL)
140      CFS2=CFS2+CTEMP*CF2(IPL)
141      CFS3=CFS3+CTEMP*CF3(IEL)
142      ALPHA=SAK*2.*AZ*R2/R
143      CTEMP=TEMP*.5/LAMBDA*CMPLX(-SF,FC)*
144      CMPLX((1.-COS(ALPHA)),SIN(ALPHA))
145      CFR1=CFR1+CTEMP*CF1(IEL)
146      CFR2=CFR2+CTEMP*CF2(IEL)
147      CFR3=CFR3+CTEMP*CF3(IPL)
148      3  CONTINUE
149      WRITE(1,2003) RX,RV,RZ,RY,CFR1,CFR2,CFR3,CFS1,CFS2,CFS3
150      2003  FORMAT(4F,7,6E13.6,7,AE13.6)
151      GO TO 201
152      C
153      C      THIS IS THE TERMINATION SECTION. THE INITIAL RECORD ON
154      C THE OUTPUT FILE IS WRITTEN AND THE PROGRAM TERMINATES.
155      200  CALL RELEAS (1)
156      CALL EXIT
157      STOP
158      END

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[illegible]

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11:09

INPUT	1		
JOINT	4		
MSIZE	2	3	5
REC	2		
MX	2	4	

IL9VER.F4

F40

V27(360)

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11:05

```

1      C
2      C THIS SUBROUTINE SIMS THE EFFECTS OF THE STRIPS THAT MAKE
3      C UP THE GROUND SURFACE. THERE ARE 'N' STRIPS DESCRIBED IN COMMON
4      C GROUND AS FOLLOWS:
5      C   X1(I) THE X-COORDINATE OF THE LEADING EDGE OF THE I'TH STRIP
6      C   Z1(I) THE Z-COORDINATE OF THE LEADING EDGE OF THE I'TH STRIP
7      C   X2(I) THE X-COORDINATE OF THE ENDING EDGE OF THE I'TH STRIP
8      C   Z2(I) THE Z-COORDINATE OF THE ENDING EDGE OF THE I'TH STRIP
9      C SUBROUTINE SCAT
10     COMMON /REC/ RX,RY,RZ
11     COMMON /ANT/ AX,AY,AZ
12     COMMON /GROUND/ N,X1(2N),Z1(2N),X2(2N),Z2(2N),IEL
13     COMMON /SEG/ XX1,ZZ1,XX2,ZZ2,N
14     C
15     C THESE ARE INITIAL VALUES FOR THE PARAMETERS USED IN SHADOWING
16     C SLOPE=-1.
17     C PHIE=-1.
18     C
19     C THIS IS THE LOOP OVER THE STRIPS
20     DO 1 I=1,N
21     C
22     C THESE ARE THE VALUES TO BE USED IN THE STRIP
23     C INTEGRATION SUBROUTINE
24     C   XX1 LEADING X-COORDINATE
25     C   ZZ1 LEADING Z-COORDINATE
26     C   XX2 TRAILING X-COORDINATE
27     C   ZZ2 TRAILING Z-COORDINATE
28     C   XX1=XX1(I)
29     C   ZZ1=ZZ1(I)
30     C   XX2=XX2(I)
31     C   ZZ2=ZZ2(I)
32     C
33     C THIS IS A TEST TO SEE IF THE SUMMATION OVER THE GROUND
34     C STRIPS HAS REACHED THE RECEIVER LOCATION. IF IT HAS THE SUMMATION
35     C IS STOPPED. THIS IS TO GIVE THE EFFECT OF FORWARD LOCKING RECEIVER
36     C ANTENNA PATTERN.
37     C IF (XX1 .GE. RX) GO TO 6
38     C
39     C IF THE RECEIVER IS LOCATED OVER THE MIDDLE PORTION OF A STRIP
40     C THE STRIP WILL BE INTEGRATE ONLY UP TO THE VALUE OF THE
41     C RECEIVER X-COORDINATE
42     C IF (XX2 .LE. RX) GO TO 5
43     C ZZ2=ZZ2+(RX-XX1)*(ZZ2-ZZ1)/(XX2-XX1)
44     C XX2=RX
45     C CONTINUE
46     C
47     C THIS SECTION DOES THE SHADOWING. IF PART OR ALL OF THE STRIP
48     C IS IN THE SHADOW OF A PREVIOUS STRIP, THIS STRIP WILL BE ELIMINATED
49     C OR MASKED TO GIVE THE EFFECT OF SHADOWING.
50     C DEL=XX2-AX
51     C IF (DELX .LE. 0.) GO TO 3
52     C PHIE=(AZ-ZZ2)/DELX
53     C IF (SLOPE .LT. P.) GO TO 3

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94      IF(PWIE .GE. SLOPE) GO TO 1
95      PWIB=(A2-ZB1)/(VX1-AV)
96      IF(PWIB .LE. SLOPE) GO TO 3
97      IF(VX1 .EQ. XZ2) GO TO 4
98      A=(ZB2-ZB1)/(XZ2-VX1)
99      B=ZB1-A*(VX1-AV)
00      XZ1=(A2-B)/(A-SLOPE)+AV
01      ZB1=SLOPE*(VX1-AV)+A2
02      4
03      C
04      C THIS SUBROUTINE WILL INTEGRATE OVER THE STRIP THE
05      C COMPLEX 'GAIN' EFFECT OF THIS STRIP WILL BE ADDED TO MW AND MI
06      C IN COMMON 'VALL'
07      3 CALL SUM
08      SLOPE=PWIE
09      1 CONTINUE
10      6 RETL'N
11      ENH

```

CONSTANTS

P 2814800000000

COMMON

01	/REC	/-0	0V	/REC	/-1	02	/REC	/-2	03	/ANT	/-0	04	/ANT	/-1
05	/ANT	/-2	06	/GROUND	/-0	07	/GROUND	/-1	08	/GROUND	/-2	09	/GROUND	/-3
10	/GROUND	/-4	11	/GROUND	/-5	12	/GROUND	/-6	13	/GROUND	/-7	14	/GROUND	/-8
15	/SEG	/-3	16	/SEG	/-4	17	/SEG	/-5	18	/SEG	/-6	19	/SEG	/-7

SUBPROGRAMS

SUM

SCALARS

SCAT	143	SLOPE	144	PWIE	145	1	146	0	0
VX1	0	ZB1	1	VZ2	2	ZB2	3	0	0
DELX	147	AV	0	02	0	PWIB	100	0	101
0	102	0V	1	03	0	AV	1	TEL	103
4	4								

ARRAYS

V1	1	Z1	29	V2	31	Z2	76
----	---	----	----	----	----	----	----

A	58	59	68							
ANT	11									
AX	11	52	55	59	68	61				
AY	11									
AZ	11	52	55	68	61					
B	59	62								
DELX	58	51	52							
GROUND	12									
I	22	28	29	38	31					
TEL	12									
K	12	22								
N	13									
PMIB	55	56								
PMIE	17	52	54	67						
REC	18									
RX	18	37	42	43	44					
RY	18									
RZ	18									
SCAT	9									
SEG	13									
SLOPE	16	53	54	56	68	61	67			
SUN	66									
X1	12	28								
X2	12	38								
XX1	13	28	37	43	55	57	58	59	68	61
XX2	13	37	42	43	44	58	57	58		
Z1	12	29								
Z2	12	31								
ZZ1	13	29	43	55	58	59	61			
ZZ2	13	31	43	52	58					
1P	28	54	68							
3P	51	53	56	66						
4P	57	61								
5P	42	45								
6P	37	69								

```

1      C
2      C      THIS SUBROUTINE INTEGRATES OVER THE SURFACE STRIP DEFINED
3      C BY X1,Z1,X2,Z2 IN COMMON 'SEG', TO GIVE THE FIELD EFFECT
4      C OF THE ANTENNA ELEMENT IN COMMON 'ANT' AT RECEIVER DEFINED
5      C IN COMMON 'REC'. THE VARIABLES ARE AS FOLLOWS:
6      C      AX      ANTENNA X-COORDINATE
7      C      AY      ANTENNA Y-COORDINATE
8      C      AZ      ANTENNA Z-COORDINATE
9      C      LAMBDA   WAVELENGTH OF CARRIER
10     C      AK      TWO*PI/LAMBDA
11     C      DPI      TWO*PI (DOUBLE PRECISION)
12     C      RX      RECEIVER X-COORDINATE
13     C      RY      RECEIVER Y-COORDINATE
14     C      RZ      RECEIVER Z-COORDINATE
15     C      HR      REL PART OF 'GAIN' FACTOR
16     C      HI      IMAGINARY PART OF 'GAIN' FACTOR
17     C      X1      LEADING EDGE OF STRIP'S X-COORDINATE
18     C      Z1      LEADING Z-COORDINATE
19     C      X2      TRAILING EDGE X-COORDINATE
20     C      Z2      TRAILING Z-COORDINATE
21     C THE INTEGRATION IS PERFORMED BY A MODIFIED TRAPIZOID RULE.
22     C THE SPACING BETWEEN POINTS ALONG THE VARIABLE OF INTEGRATION
23     C IS VARIED BY THE RATE OF CHANGE OF THE INTEGRAND.
24     C      SUBROUTINE SUM
25     C      COMMON /SEG/ X1,Z1,X2,Z2,N
26     C      DOUBLE PRECISION A1,A2,B1,B2,XL,AY2
27     C      REAL JR,J1,JOR,JOI,JNR,JNI
28     C      REAL LAMBDA
29     C      DOUBLE PRECISION AK,DPI,DR
30     C      COMMON /ANT/AX,AY,AZ,LAMBDA,AK,DPI
31     C      COMMON /REC/RX,RY,RZ
32     C      COMMON /VAL/HR,HI
33     C      REAL L3,L10
34     C
35     C      THIS IS THE INITIALIZATION SECTION
36     C      AY2=DBLE(AY)*DBLE(AY)
37     C      AKK=8*AK
38     C      SF=Z2-Z1
39     C      CL=X2-X1
40     C
41     C      XMAX IS THE LENGTH ALONG THE SURFACE OF THE STRIP
42     C      XMAX=SQRT(SE*SE+CE*CE)
43     C
44     C      THESE ARE THE SIN AND COS OF THE ANGLE THE STRIP MAKES WITH
45     C A HORIZONTAL PLANE
46     C      SE=SE/XMAX
47     C      CE=CE/XMAX
48     C      JR=0.
49     C      J1=0.
50     C
51     C      XL IS THE VARIABLE OF INTEGRATION. IT IS THE DISTANCE
52     C LONG THE SURFACE OF THE STRIP STARTING FROM THE LEADING EDGE
53     C      XL=0.

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ILSVEN.F4

F40

V27(362)

22-APR-76

11:05

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94      NX=1
95      IT=0
96      C
97      C THESE ARE THE LOWER AND UPPER BOUNDS FOR THE SPACING BETWEEN
98      C POINTS ALONG THE VARIABLE OF INTEGRATION
99      L3= LAMBDA/24,
100     L10=20.*LAMBDA
101     A1=RX-X1
102     A2=RF-Z1
103     B1=X1
104     B2=Z1-A2
105     A=A1
106     TEMP=A2
107     A= SQRT(A*A+TEMP*TEMP)
108     B=B1
109     TEMP=B2
110     B= SQRT(B*B+TEMP*TEMP)
111     TEMP=A*B
112     DR=DSORT(DBLE(TEMP)*DBLE(TEMP)+DBLE(AV*AV))
113     C=DR
114     DR=DR*AK
115     I=DR/DPI
116     F=DR*DBLE(FLOAT(I))*DPI
117     C=C/TEMP
118     D=C*B
119     R=C*A
120     S=SQRT((1./A+1./B)/C/C/C)
121     G=A1/D/D/R/R/S
122     TEMP=G/(AK*D)
123     CF=COS(F)
124     SF=SIN(F)
125     JOR=G*CF+TEMP*SF
126     JOI=G*SF+TEMP*CF
127     AP=(A1*CE-A2*SE)/A
128     BP=(B1*CE-B2*SE)/B
129     C
130     C FP IS THE DERIVATIVE OF THE PHASE FUNCTION
131     C OF THE INTEGRAND
132     FP=ABS((AP*BP)/C)
133     C
134     C DL IS DELTA XL
135     DL=L3/FP
136     IF(DL .GT. L10) DL=L10
137     IF(DL .LT. L3) DL=L3
138     XL=XL+DL
139     C
140     C THIS IS THE LOOP OVER THE SURFACE OF THE STRIP. XL IS
141     C INCREMENTED BY DL (OF VARIABLE SIZE) UNTIL THE END OF THE STRIP
142     C IS REACHED (XMAX)
143     1 CONTINUE
144     C
145     C THIS SECTION CALCULATE VARIOUS TERMS USED IN EVALUATING THE
146     C INTEGRAND, THE AMPLITUDE AND PHASE FUNCTION

```

JLBYEN,F4

F4B

V27(368)

22-APR-76

11185

```

107 C ARE EVALUTATED SEPARATELY. THE DERIVATIVE OF THE PHASE FUNCTION
108 C IS EVALUATED TO DETERMINE THE SIZE FOR DELTA X
109 DLSE=DL*SE
110 DLCE=DL*CE
111 A1=A1-DLCE
112 A2=A2-DLSE
113 B1=B1-DLCE
114 B2=B2-DLSE
115 A=A1
116 TEMP=A2
117 A= SORT(A+A*TEMP*TEMP)
118 B=B1
119 TEMP=B2
120 B= SORT(B+B*TEMP*TEMP)
121 TEMP=A*B
122 DR=DSORT(DBLE(TEMP)*DBLE(TEMP)*DBLE(AY*AY))
123 C=SINCL(DR)/TEMP
124 DR=DR*AK
125 I=DR/DPI
126 C
127 C THIS IS THE PHASE ANGLE *MODULO TWO P *
128 F=DR*DBLE(FLOAT(I))*DPI
129 D=C*R
130 R=C*A
131 S=SQRT((1./A+1./B)/C)/C
132 G=A1/(D*D*R+R*S)
133 C
134 C THIS IS THE AMPLITUDE FUNCTION
135 TEMP=G/(AKK*D)
136 CF=COS(F)
137 SF=SIN(F)
138 C
139 C THIS IS THE REAL PART OF THE INTEGRAND FOR THE
140 C INTEGRATION VARIABLE VALUE OF XL
141 JNR=G*CF-TEMP*SF
142 C
143 C THIS IS THE IMAGINARY PART
144 JN1=G*SF+TEMP*CF
145 TEMP=DL
146 C
147 C THESE ARE THE REAL AN IMAGINARY PARTS OF THE THE SUMMATION
148 C OF THE TRAPIZOIDS MAKING UP THE APPROXIMATION TO THE INTEGRAL
149 JR=JR+(JNR*JNR)*TEMP
150 J1=J1+(JN1*JN1)*TEMP
151 IF(IT.NE.0) GO TO 2
152 JDR=JNR
153 JN1=JN1
154 AP=(A1*CE-A2*SE)/A
155 BP=(B1*CE-B2*SE)/B
156 C
157 C FP IS THE DERIVATIVE OF THE PHASE FUNCTION
158 FP=ABS((AP*BP)/C)
159 C

```

ILSVEN,F4 F40 J27(362) 22-APR-76 11:05

```

160 C DL IS DELTA X AND IS LIMITED BY THE BOUNDS L1,L32
161 DL=LS/PP
162 IF(DL.GT. L18) DL=L1P
163 IF(DL.LT. L3) DL=L3
164 X=X+DL
165
166 C THE VARIABLE OF INTEGRATION IS INCREMENTED AND IF THE END OF THE
167 C STRIP IS REACHED THE LAST TRAPEZOID IS ADDED
168 XL=XL+DL
169 IF( XL.LT. XMAX) GO TO 1
170 DL=XMAX-DL-XL
171 XL=XMAX
172 IT=IT+1
173 GO TO 1
174
175 C THIS SECTION ADDS THE FIELD EFFECT FROM THE STRIP TO THE
176 C TOTAL FIELD SUM AND THE SUBROUTINE TERMINATES
177 CONTINUE
178 N=NX
179 TEMPO=((Z1-A2)*CE-X1*SF)/2.
180 HR=HR+JH*TEMP
181 H1=H1+J1*TEMP
182 RETURN
183 END

```

CONSTANTS

P 2856P28P770

COMMON

X1	/SEG	/-P	Z1	/SEG	/-1	X2	/SEG	/-2	Z2	/SEG	/-3	N	/SEG	/-4
AK	/ANT	/-8	AY	/ANT	/-1	A2	/ANT	/-2	LAMBDA	/ANT	/-3	AK	/ANT	/-4
DP1	/ANT	/-6	RX	/REC	/-8	RY	/REC	/-1	R2	/REC	/-2	HR	/VAL	/-9
H1	/VAL	/-1												

SUBPROGRAMS

DBLE	DFM.2	SNGL	DSORT	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2
DFM.6	DFM.4	DFM.4	ABS	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2	DFM.2

SCALARS

SUM	1864	A2	1865	AY	1	AKK	1867	AK	4
SE	1870	B2	3	Z1	1	CE	1871	X2	2
X1	8	XMAX	1872	JH	1873	J1	1874	XL	1875
X2	1877	IT	11P8	L3	1181	LAMBDA	3	L18	1182
A1	1183	RX	8	A2	1189	R2	2	B1	1187
B2	1111	A2	2	A	1113	TEMP	1114	8	1119
DP	1111	C	1122	1	1121	DP1	8	F	1122
D	1123	R	1124	5	1128	G	1126	CF	1127
XF	1138	JH	1131	JH	1132	AP	1133	BP	1134
FP	1139	DL	1136	DLSE	1137	DLCE	1140	JHR	1141

ILSVEN,F4 F40 J27(362) 22-APR-76 11:05

JH	142	4	4	HR	8	H1	1	AK	8
1									

A	65	67	71	79	88	87	119	117	121	130	131	194
A1	26	61	65	81	87	111	119	132	134			
A2	29	62	66	87	112	116	124					
ABS	92	150										
AL	29	39		74	124							
AKH	37	82	129									
ANT	39											
AP	87	92	194	198								
AK	39											
AV	38	36	72	122								
AYZ	26	36										
AZ	39	64	179									
B	69	78	71	78	88	88	118	120	121	129	131	198
B1	26	63	68	88	113	118	129					
B2	26	64	69	88	114	119	129					
BP	88	92	195	198								
C	73	77	78	79	88	92	123	124	130	131	190	
CE	36	42	47	87	88	118	124	129	179			
CF	83	85	86	136	141	144						
COB	83	136										
D	78	81	82	129	132	135						
DOL	36	72	76	122	128	129						
DL	95	96	97	98	129	135	145	161	162	163	168	178
OLCE	118	111	113			118						
OLSE	189	112	114									
OP1	29	38	75	74	125	128						
OR	29	72	73	74	79	76	122	123	124	129	189	
OSORT	72	122										
F	74	83	84	128	136	137						
FLOAT	74	128										
FP	92	95	198	161								
G	81	82	85	86	132	135	141	144				
HI	32	181										
HM	32	188										
I	78	74	125	128								
IT	95	191	172									
J1	27	49	198	161								
JN1	27	144	198	193								
JNR	27	141	149	192								
JOT	27	86	198	193								
JOR	27	85	149	192								
JR	27	48	149	188								
L10	32	68	94	162								
L3	32	59	95	97	161	163						
LAMBDA	28	39	59	60								
N	28	178										
NX	94	164	178									
R	79	81	138	132								
REC	31											
RX	31	61										
RY	31											
Q2	31	62										
S	88	81	131	132								
SE	38	42	46	87	88	189	194	195	179			
SEB	29											
SH	84	85	86	137	141	144						
SIN	84	137										
SMBL	37	123										
SORT	42	67	78	88	117	128	131					
SUM	24											
TEMP	46	67	69	78	71	72	77	82	85	86	116	117
V1	111	122	123	135	141	144	145	149	198	179	188	181
V2	32											
X1	29	39	61	63	179							
X2	29	39										
X3	26	93	98	188	169	178	171					
XMAX	42	44	47	169	178							
Z1	23	38	62	64	178							
Z2	23	38										
1P	183	189	173									
2P	191	177										

APPENDIX B MOLE

13:50

41

MOLE,F4 F40 V27(369) 23-APR-76 13:52

```

94      CFR1=CFR1+CT
95      CFS1=CFR1+CT
96      CT=CTEMP+CF2(1)
97      CFR2=CFR2+CT
98      CFS2=CFR2+CT
99      CT=CTEMP+CF3(1)
100     CFS3=CFR3+CT
101     CFR3=CFR3+CT
102     S      CONTINUE
103     WRITE(1,2005) RX,RV,RZ,RT,CFR1,CFR2,CFR3,CFS1,CFS2,CFS3
104     GO TO 201
105
106     C      THIS IS THE TERMINATION SECTION. THE INITIAL RECORD ON
107     C THE OUTPUT FILE IS WRITTEN AND THE PROGRAM TERMINATES.
108     200    CALL RELEASE (1)
109     CALL EXIT
110     STOP
111     END

```

CONSTANTS

8 203622077325 1 158842855861 2 000000000025 3 000000000001 4 000000000000

COMMON

VAR	/PLXT	/+0	RXNX	/PLXT	/+1	RXNY	/PLXT	/+2	RXRT	/PLXT	/+3	RZLT	/PLXT	/+4
RYMX	/PLXT	/+5	RYNY	/PLXT	/+6	RYRT	/PLXT	/+7	RYLT	/PLXT	/+10	RYNN	/PLXT	/+11
RZMX	/PLXT	/+12	RZNY	/PLXT	/+13	RZRT	/PLXT	/+14	RYMX	/PLXT	/+15	RZMX	/PLXT	/+16
RTFT	/PLXT	/+17	RTLT	/PLXT	/+18	ARMX	/PLXT	/+21	ALMX	/PLXT	/+22	ALPT	/PLXT	/+23
ALIT	/PLXT	/+24	ARMN	/PLXT	/+25	ADIF	/PLXT	/+26	ADIL	/PLXT	/+27	ADRT	/PLXT	/+28
ADIN	/PLXT	/+31	ADIX	/PLXT	/+32	ADRL	/PLXT	/+33	RX	/REC	/+34	RY	/PLXT	/+35
ADRX	/PLXT	/+36	ADRF	/PLXT	/+37	NSIRE	/REC	/+40	AX	/ANT	/+6	AY	/REC	/+1
RE	/REC	/+2	RT	/REC	/+3	DAK	/ANT	/+4	DPI	/ANT	/+8	WR	/VAL	/+0
RE	/ANT	/+2	LAMBDA	/ANT	/+3	GRNC	/ANT	/+14	IPDAT	/PLXT	/+0			
NI	/VAL	/+1	P	/GRND	/+8									

SUBPROGRAMS

FORGE, JUFF ALPHO, ALPHI, IFILE OFILE ALLTD, FLOUT, FLIRT, BINNR, OBLE DFD,2 END, INTR2 CFM,2

SCALARS

API	6	ILBL	406	1	407	J	410	TAU	411
LAMBDA	3	NEL	412	DAK	4	RX	8	RY	1
RE	2	RT	5	CFR1	413	CFR2	415	CFR3	417
CFS1	421	CFS2	423	CFR3	425	AX	8	AY	1
AR	2	CTEMP	427	CT	431	WRP	8	RXNX	1
RXMX	2	RFTT	3	RLTY	4	RYNN	9	RYMX	6
RYFT	7	RYLT	10	RZMX	11	RZNY	12	RZRT	13
RZLT	14	RZNY	15	RTFT	16	RTLT	17	RTLT	20
ALMX	21	ALNX	22	ALPT	23	ALIT	24	ARMN	25

13:53

481X	32
480V	37

2 913
4 14

43

REC	13			
RELEAS	68			
RT	13	42	63	
RTPT	3			
RTLT	3			
RTMN	3			
RTMX	3			
RX	13	42	63	
RXPT	3			
RXLT	3			
RXMN	3			
RXXM	3			
RY	13	42	63	
RYPT	3			
RYLT	3			
RYMN	3			
RYMX	3			
RZ	13	42	63	
RZPT	3			
RZLT	3			
RZMN	3			
RZMX	3			
TAU	33			
VAL	16			
X	18	39	48	48
Y	18	39	48	49
Z	18	39	48	50

3P	35	37			
5P	47	62			
202P	42	68			
201P	42	64			
1000P	33	34	36	37	38
2000P	24	25	29		
2001P	22	23			
2002P	27	28			
2003P	42	44	63		
3000P	45	46			
4000P	31	32			

NOLE,F4 F43 V27(368) 22-APR-76 13:53

```

1      SUBROUTINE NORMAL(V1,V2,V3,V4,R)
2      DIMENSION V1(1),V2(1),V3(1),V4(1)
3      X1=V2(1)-V1(1)
4      X2=V3(1)-V1(1)
5      V1=V2(2)-V1(2)
6      V2=V3(2)-V1(2)
7      Z1=V2(3)-V1(3)
8      Z2=V3(3)-V1(3)
9      X=V1+Z2-V2+Z1
10     Y=Z1+X2-Z2+X1
11     Z=X1+V2-V1+X2
12     R=SQRT(X*X+Y*Y+Z*Z)
13     V4(1)=X/R
14     V4(2)=Y/R
15     V4(3)=Z/R
16     RETURN
17     END

```

GLOBAL DUMMIES

V1	133	V2	134	V3	135	V4	136	R	137
----	-----	----	-----	----	-----	----	-----	---	-----

SUBPROGRAMS

SOBT

SCALARS

NORMAL	141	X1	142	X2	143	V1	144	V2	145
Z1	146	Z2	147	Y	148	V	149	Z	150
R	151								

ARRAYS

V1	133	V2	134	V3	135	V4	136
----	-----	----	-----	----	-----	----	-----

NORMAL	1								
R	1	12	13	14	15				
SOBT	12								
V1	1	2	3	4	5	6	7	8	
V2	1	2	3	4	5	6	7	8	
V3	1	2	3	4	5	6	7	8	
V4	1	2	3	4	5	6	7	8	
X	9	12	13	14	15				
X1	1	12	13						
X2	4	12	13						
Y	10	12	13						
Y1	9	9	11						
Y2	6	9	11						
Z	11	12	13						
Z1	7	9	10						
Z2	8	9	10						

MOLE,F4 F42

V27(368)

23-APR-76

13:53

```

1      DOUBLE PRECISION FUNCTION DIST(X,Y)
2      DIMENSION X(1),Y(1)
3      DOUBLE PRECISION R,TEMP
4      R=0.
5      DO 1 I=1,3
6          TEMP=X(I)-Y(I)
7          R=R+TEMP*TEMP
8      DIST=DSORT(R)
9      RETURN
10     END

```

GLOBAL DUMMIES

X 56 Y 57

SUBPROGRAMS

DFM,2 DFAM,2 DSORT

SCALARS

DIST 68 R 62 I 64 TEMP 65

ARRAYS

X 56 Y 57

DIST	1	8		
DSORT	8			
I	5	6		
R	3	4	7	8
TEMP	3	6	7	
X	1	2	6	
Y	1	2	6	

1P 5 7

```

1      SUBROUTINE INTR2(CTEMP)
2      DATA D1,D2/23.,.40./
3      DIMENSION XTA(3),ZTA(3)
4      DOUBLE PRECISION D10,D20,R10,R20
5      COMPLEX A,B
6      DOUBLE PRECISION D01,D02
7      COMPLEX CTEMP,CCY,CCX,CCV,CCX0
8      REAL N,LAMBDA,M1,M2,M3
9      COMMON /SRND/ P(3,4),N(3)
10     EQUIVALENCE (N(1),M1),(N(2),M2),(N(3),M3)
11     DOUBLE PRECISION DAK,DPI
12     COMMON /REC/ XN,YN,ZP
13     COMMON /ANT/XA,YA,ZA,LAMBDA,DAK,DPI
14     EQUIVALENCE (P(1),P(1,1)),(P(2),P(1,2)),(P(3),P(1,3))
15     EQUIVALENCE (P(4),P(2,4)),(P(3),P(3,1)),(P(3),P(3,4))
16     LOGICAL TEST
17     DATA TEST/.TRUE./
18     IF(TEST) CALL NORMAL(P(1),P(2),P(1,4),M(1),TEMP)
19     TEST=.FALSE.
20     ZAR=Z+.ZA
21     TP=SNGL(DPI)
22     AK=SNGL(DAK)
23     CTEMP=(0.,0.)
24     DELX=0
25     DCG=PI*ST(0(1,1),0(1,2))
26     IX=DGG/DELX
27     IF(IX .LT. 0) IX=-IX
28     IF(IX .LT. 1) IX=1
29     IX=((IX+1)/2)*2
30     DELX=DGG/FLOAT(IX)
31     XTA(1)=(P(1,2)-P(1,1))/DCG
32     XTA(2)=(P(2,2)-P(2,1))/DCG
33     XTA(3)=(P(3,2)-P(3,1))/DCG
34     DCGX=XTA(1)*DELX
35     DCGY=XTA(2)*DELX
36     DCGZ=XTA(3)*DELX
37     DCG=PI*ST(P(1,1),P(1,4))
38     DELZ=0
39     IZ=DG1/DELZ
40     IF(IZ .LT. 0) IZ=-IZ
41     IF(IZ .LT. 1) IZ=1
42     IZ=((IZ+1)/2)*2
43     DELZ=DG1/FLOAT(IZ)
44     ZTA(1)=(P(1,4)-P(1,1))/DG1
45     ZTA(2)=(P(2,4)-P(2,1))/DG1
46     ZTA(3)=(P(3,4)-P(3,1))/DG1
47     DCGX=ZTA(1)*DELZ
48     DCGY=ZTA(2)*DELZ
49     DCGZ=ZTA(3)*DELZ
50     DO 1 IXX=1,IX
51     FX=FLOAT(IXX)*.5
52     XS=P(1,1)+FX*DCGX
53     YS=P(2,1)+FX*DCGY

```

WOLB, F4 F48

V27(368)

23-APR-7A

13:50

```
54 ZS=P(3,1)*FX*DC62
55 DO 2 IZ=1,12
56 FZ=FLOAT(IZ)-.5
57 XS=XS-FZ*DC61X
58 VS=VS-FZ*DC61Y
59 ZS=ZS-FZ*DC61Z
60 CC6=XR-XS
61 CC7=XS-XA
62 TEMP=VR-VS
63 TEMP2=ZR-ZS
64 TEMP3=ZR-ZS
65 DR1=70LE(CC6*CC6)+70LE(TEMP*TEMP)
66 DR2=70LE(TEMP3*TEMP3)
67 DR1=70LE(TEMP2*TEMP2)
68 R12=70R1
69 R22=70R2
70 R12=70R1
71 R22=70R2
72 R1=70R1
73 R2=70R2
74 TEMP=VS-VA
75 TEMP2=ZS-ZA
76 TEMP3=ZS-ZA
77 DR1=70LE(CC7*CC7)+70LE(TEMP*TEMP)
78 DR2=70LE(TEMP3*TEMP3)
79 DR1=70LE(TEMP2*TEMP2)
80 D12=70R1
81 D22=70R2
82 D12=70R1
83 D22=70R2
84 D1=70D1
85 D2=70D2
86 F12=42*XS*(VR-VS)+(41*VS+43*(ZS-PA))*(XR-XS)
87 F22=F12+43*(XR-XS)+2A2
88 COSA1=(XTA(1)*CC7+XTA(2)*(VS-VA)+XTA(3)*(ZS-2A))/D1
89 COSA1=(XTA(1)*CC7+XTA(2)*(VS-VA)+XTA(3)*(ZS-2A))/D2
90 COSG1=(XTA(1)*CC6+XTA(2)*(VR-VS)+XTA(3)*(ZR-ZS))/R1
91 COSG1=(XTA(1)*CC6+XTA(2)*(VR-VS)+XTA(3)*(ZR-ZS))/R2
92 COSB1=(ZTA(1)*CC7+ZTA(2)*(VS-VA)+ZTA(3)*(ZS-2A))/C1
93 COSB1=(ZTA(1)*CC7+ZTA(2)*(VS-VA)+ZTA(3)*(ZS-2A))/D2
94 COSD1=(ZTA(1)*CC6+ZTA(2)*(VR-VS)+ZTA(3)*(ZR-ZS))/R1
95 COSD1=(ZTA(1)*CC6+ZTA(2)*(VR-VS)+ZTA(3)*(ZR-ZS))/R2
96 CM=COSA-COSG
97 CM1=COSA-COSG1
98 CM2=COSA1-COSG
99 CM3=COSA1-COSG1
100 C=COSB-COSD
101 C1=COSB-COSD1
102 C2=COSB1-COSD
103 C3=COSB1-COSD1
104 D12=70D1
105 D22=70D2
106 R12=70R1
```

MOLE,F4 F40 V87(360) 23-APR-76 13:50

```

107 R20=R20+QAN
108 ID=010/DP1
109 D1=010-DBLE(FLOAT(ID))*DP1
110 ID=020/DP1
111 D2=020-DBLE(FLOAT(ID))*DP1
112 ID=030/DP1
113 R1=R10-DBLE(FLOAT(ID))*DP1
114 ID=020/DP1
115 R2=R20-DBLE(FLOAT(ID))*DP1
116 TEMP=F10+SIN(AK*CH*DELX*.5)*SIN(AK*CD*DELR*.5)/(CH*CD12*R12)
117 CTENP=CTENP+TEMP*CEXP(CMPLX(R.,D1*R1))
118 TEMP=F10+SIN(AK*CH1*DELX*.5)*SIN(AK*CD1*DELR*.5)/(CH1*CD12*R12)
119 CTENP=CTENP+TEMP*CEXP(CMPLX(R.,D1*R1))
120 TEMP=F20+SIN(AK*CH2*DELX*.5)*SIN(AK*CD2*DELR*.5)/(CH2*CD22*R12)
121 CTENP=CTENP+TEMP*CEXP(CMPLX(R.,D2*R1))
122 TEMP=F20+SIN(AK*CH3*DELX*.5)*SIN(AK*CD3*DELR*.5)/(CH3*CD32*R12)
123 CTENP=CTENP+TEMP*CEXP(CMPLX(R.,D2*R1))
124 2 CONTINUE
125 1 CONTINUE
126 CTENP=CTENP*2./(TP1+TP1)
127 ICC=X*12
128 RETURN
129 END

```

CONSTANTS

B 000000000000 1 P2000000000 2 P0000000001 3 000000000002

GLOBAL DUMMIES

CTEMP 1341

COMMON

P	/GRND	/+0	N	/GRND	/+14	YR	/REC	/+0	YR	/REC	/+1	BR	/REC	/+2
XA	/ANT	/+0	YA	/ANT	/+1	Z4	/ANT	/+2	LAMBDA	/ANT	/+3	DAK	/ANT	/+4
DP1	/ANT	/+0	N1	/GRND	/+14	Y2	/GRND	/+15	N3	/GRND	/+16	P11	/GRND	/+0
P12	/GRND	/+3	P21	/GRND	/+1	P24	/GRND	/+12	P31	/GRND	/+2	P34	/GRND	/+13

SUBPROGRAMS

NORMAL	SNGL	DIST	D	IFIX	CFD.4	FL0AT	DBLE	DFA.2	DFAH.0	D00RT	DFMM.2	DFD.2	IQINT	DFM.0	DEF.0
R 4	CEXP	CMPLX	CFM.0	CFD.4											

SCALARS

INTR2	1347	DX	1392	DY	1391	TEST	1392	P11	0
P12	3	TEMP	1393	Z42	1394	Z4	2	TP1	1395
DT	6	AK	1396	TAH	4	CTENP	1341	DELX	1397
Q00	1340	IX	1361	CGPX	1362	D00RY	1363	D00Z	1364
Q01	1365	DEL2	1366	I2	1367	OC1X	1370	OC1Y	1371
OC12	1372	IXX	1373	FX	1374	X5	1375	Y5	1376
Z0	1377	I22	1400	F2	1401	CC6	1402	YR	0

v27(348)

23-APR-76

14:00P

CC7	1483
TEmp3	1485
q18	1414
q12	1422
q2	1431
F2P	1433
COSu	144P
CM1	1445
C2	1492
p21	1

XA	P
DR1	1408
R2P	1416
D22	1423
F10	1432
COSA	1436
COSB1	1441
CH2	1446
C3	1493
P24	12

VR	1
782	1418
#1	1428
718	1424
*2	15
GOSA1	1439
GOSO	1442
CM3	1447
17	1454
#31	2

TEMP2	1404
R12	1412
R2	1421
O20	1420
V1	14
CCSG	1436
CCSC1	1443
C	1450
ICC	1455
PJA	13

2R	2
R22	1413
YA	1
DI	1438
43	16
COSG1	1437
CM	1444
C1	1451
LAMBDA	3

ARRAYS

ETA 1456

2TA 1461

• •

N 14

[illegible]

APPENDIX C GLDCDI

```

1      DIMENSION ILABL(8)
2      DIMENSION IPTDAT(33)
3      COMMON /PLXT/ NRP,RXHN,RXNX,RXFT,RXLT,RVHN,RVNX,RVFT,RVLT,
4      1RXHN,RXNX,RXFT,RXLT,RTMN,RTMX,RTFT,RTLT,
5      2AINN,AINX,AIFT,AILT,ARMN,ARMX,ARFT,ARLT,
6      3ADIN,ADIX,ADIF,ADIL,
7      4ADRN,ADRX,ADRF,ADRL,
8      EQUIVALENCE (IPTDAT(1),NRP)
9      IMPLICIT COMPLEX (C)
10     DIMENSION X(20),Y(20),Z(20)
11     DIMENSION CF1(20),CF2(20),CF3(20)
12     IMPLICIT DOUBLE PRECISION (D)
13     COMMON /REC/RX,RV,RZ,RT,NSIZE
14     REAL LAMBDA
15     COMMON /GROUND/ K,X1(20),Z1(20),X2(0/20),Z2(0/20),IEL
16     COMMON /ANT/AX,AY,AZ,LAMBDA,DAK,DPI
17     COMMON /VAL/ NR,M1
18
19     C
20     C      THIS VALUE OF TWO PI IS INITIALIZED THIS WAY TO AVOID USING
21     C BLOCK DATA
22     C
23     2001 FORMAT(' INPUT FILE NAME:',S)
24     READ(9,2001) ILBL
25     2002 FORMAT(A9)
26     CALL IFILE(20,ILBL)
27     WRITE(9,2002)
28     2003 FORMAT(' OUTPUT FILE NAME:',S)
29     READ(9,2003) ILBL
30     CALL OFILE(1,ILBL)
31     WRITE(1) IPTDAT
32     READ(20,1000) ILABL,TAU
33     WRITE(1,1000) ILABL
34     DO 3 I=1,2
35     READ(20,1000) ILABL
36     3 WRITE(1,1000) ILABL
37     1000 FORMAT(8A9,F)
38     READ(20) LAMBDA,NEL,(X(I),Y(I),Z(I),CF1(I),CF2(I),CF3(I),I=1,NEL)
39     201 READ(20,2005,END=200) RX,RV,RZ,RT,
40     1CFR1,CFR2,CFR3,CFS1,CFS2,CFS3
41     2005 FORMAT(4F,/,6E13.6,/,6E13.6)
42
43     C
44     C THE CDI'S ARE CALCUATED
45     C ACOR CDI FOR THE GROUND SURFACE
46     C ACDI CDI FOR 'IDEAL' GROUND PLANE
47     ACOR=0.97,14*REAL((CFR2-CFR3)/CFR1)
48     ACDI=0.97,14*REAL((CFS2-CFS3)/CFS1)
49
50     C
51     C      NCRP IS THE COUNT OF THE RECEIVERPOINTS
52     NRP=NRP+1
53     IF(NRP.NE.1) GO TO 4

```

GLDC01.F4

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94      C      THIS SECTION INITIALIZES THE MAXIMUM AND MINIMUM VALUES
95      C OF THE VARIOUS RANGE AND DOMAIN VARIABLES. THESE ARE
96      C USED IN THE PLOTTING PROGRAM TO SCALE THE PLOTS. AFTER THE
97      C RUN IS FINISHED THEY WILL BE OUTPUT IN PLACE OF THE
98      C INITIAL DUMMY RECORD
99      ADDI=ACDI
100     ADDR=ACDR
101     T0=RT
102     ADIX=ACDI
103     ADIN=ACDI
104     ADIF=ACDI
105     ADRX=ACDR
106     ADR=ACDR
107     ADRF=ACDR
108     RXFT=RX
109     RYFT=RY
110     RZFT=RZ
111     RTFT=RT
112     AIFT=ACDI
113     ARFT=ACDR
114     RXMN=RX
115     RXMX=RX
116     RYMN=RY
117     RYMX=RY
118     RZMN=RZ
119     RZMX=RZ
120     RTMN=RT
121     RTMX=RT
122     AIMX=ACDI
123     AIMN=ACDI
124     ARMX=ACDR
125     ARMN=ACDR
126
127      C
128      C      THIS SECTION UPDATES THE MAXIMUM AND MINIMUM VALUES
129      C CONTINUE
130      RYLT=RY
131      RZLT=RZ
132      RTLT=RT
133      AILT=ACDI
134      ARLT=ACDR
135      IF(RY .LT. RXMN) RXMN=RY
136      IF(RY .GT. RXMX) RXMX=RY
137      IF(RY .LT. RYMN) RYMN=RY
138      IF(RY .GT. RYMX) RYMX=RY
139      IF(RZ .GT. RZMX) RZMX=RZ
140      IF(RZ .LT. RZMN) RZMN=RZ
141      IF(RT .GT. RTMX) RTMX=RT
142      IF(RT .LT. RTMN) RTMN=RT
143      IF(ACDI .GT. AIMX) AIMX=ACDI
144      IF(ACDI .LT. AIMN) AIMN=ACDI
145      IF(ACDR .GT. ARMX) ARMX=ACDR
146      IF(ACDR .LT. ARMN) ARMN=ACDR

```

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```

107      CD=EXP((T0-RY)/TAU)
108      C
109      THIS SECTION SIMULATE THE EFFECT OF THE ELECTRICAL AND
110      MECHANICAL 'INERTIA' OF THE ILS
111      C RECEIVER SYSTEM FOR DYNAMIC SIMULATION
112      T0=RY
113      ADDICOM=(ADDI-ACDI)*ACDI
114      ADDRCON=(ADDR-ACOR)*ACOR
115      IF(ADDI.LT. ADIN) ADIN=ADDI
116      IF(ADDR.LT. ADIN) ADIN=ADDR
117      ADIL=ADDI
118      IF(ADDR.LT. ADDR) ADDR=ADDR
119      IF(ADDR.LT. ADDR) ADDR=ADDR
120      ADDR=ADDR
121      C
122      THIS IS THE OUTPUT OF THE REAL AND 'IDEAL' , STATIC
123      C AND DYNAMIC CDI'S WITHIN THE RECEIVER COORDINATES
124      WRITE(1,2003) R ,RY,RZ,R*,ACDI,ACOR,ADDI,ACOR
125      2003 FORMAT(8F)
126      GO TO 201
127      C
128      THIS IS THE TERMINATION SECTION. THE INITIAL RECORD ON
129      C THE OUTPUT FILE IS WRITTEN AND THE PROGRAM TERMINATES.
130      200 CALL RELEAS (1)
131      ENCODE (0,2006,ILAB(1)) I,BL
132      2006 FORMAT(A9,'.DAT')
133      CALL OFFLINE FILE(1,25.1,ILAB(1))
134      WRITE(101) IPTDAT
135      CALL RELEAS (1)
136      CALL EXIT
137      STOP
138      END

```

CONSTANTS

#	203622077325	1	100042059061	2	000000000024	3	000000000001	4	212054443696
5	000000000031								

COMMON

WRP	/PLXT	/+0	RZMX	/PLXT	/+1	RZMX	/PLXT	/+2	RZFT	/PLXT	/+3	RZLT	/PLXT	/+4
RYMX	/PLXT	/+5	RYMX	/PLXT	/+6	RYFT	/PLXT	/+7	RYLT	/PLXT	/+10	RZMX	/PLXT	/+11
RZMX	/PLXT	/+12	RZFT	/PLXT	/+13	RZLT	/PLXT	/+14	RYMX	/PLXT	/+15	RZMX	/PLXT	/+16
RZFT	/PLXT	/+17	RYLT	/PLXT	/+20	AIMX	/PLXT	/+21	AIMX	/PLXT	/+22	AIMT	/PLXT	/+23
AILT	/PLXT	/+24	ARMX	/PLXT	/+25	ARMX	/PLXT	/+26	ARFT	/PLXT	/+27	ARLT	/PLXT	/+28
ADIN	/PLXT	/+31	ADIX	/PLXT	/+32	ADIF	/PLXT	/+33	ADIL	/PLXT	/+34	ADRN	/PLXT	/+35
ADRN	/PLXT	/+36	ADRT	/PLXT	/+37	ADRL	/PLXT	/+40	RY	/REC	/+0	RY	/REC	/+1
RZ	/REC	/+2	RY	/REC	/+3	RYZE	/REC	/+4	K	/GROUND	/+0	IL	/GROUND	/+1
RI	/GROUND	/+4	X2	/GROUND	/+51	E2	/GROUND	/+70	TEL	/GROUND	/+123	AE	/ANT	/+0
AT	/ANT	/+1	AE	/ANT	/+2	LAMBDA	/ANT	/+3	DAN	/ANT	/+4	DP1	/ANT	/+6
WR	/VAL	/+2	WI	/VAL	/+1	IPTDAT	/PLXT	/+8						

SUBPROGRAMS

SLB5D1,F4 F40 V27(399) 22-APR-76 11184

FORGE, VADOR,	JOFF DEFINE	ALPHO. RECNO.	ALPHI. RANAC.	IFILE EXIT	OFIL	QINWP,	FLOUT.	FLIRT.	END.	REAL	CFB.2	EXP	CFM.2	RELEASE
SCALARS														
DP1	6		ILBL	967		TAU	978		1	991			LAMBDA	3
NEL	972		RI	8		RY	1		98	2			RT	3
CFR1	373		CFR2	979		CFR3	977		CFB1	681			CFB2	683
CFB3	689		ACOR	687		ACD1	618		WHP	8			ADD1	611
ADDR	612		TG	613		ADIX	32		ADIN	31			ADIF	33
ADRE	38		ADRN	35		ADRT	37		ADFT	31			RIPT	7
ADPT	13		RTFT	17		AIFT	23		ADFT	27			RRNN	1
RYNN	2		RYNN	9		RYNN	6		RYNN	11			RRNN	12
RYNN	19		RYNN	16		RYNN	22		RYNN	21			RRNN	20
ADRN	29		RYNN	4		RYNN	10		RYNN	14			RYNN	29
AIFT	24		RYNN	38		RYNN	614		ADIL	34			ADIL	48
RYNN	4		RYNN	8		RYNN	123		RYNN	1			RYNN	1
RYNN	2		RYNN	4		RYNN	8		RYNN	1			RYNN	1
ARRAYS														
ILABL	616		IPYDAT	8		X	626		V	692			X	676
CF1	722		CF2	772		CF2	1842		X1	1			X1	22
W2	91		R2	76										

ACB1	48	59	62	63	64	72	82	83	93	103	104	113	124
ACOR	47	68	65	66	67	73	84	85	94	105	106	114	124
ADD1	39	113	115	116	117	124							
ADDR	68	114	118	119	120	124							
ADIF	3	64											
ADIL	3	117											
ADIN	3	63	119										
ADIX	3	62	116										
ADRE	3	67											
ADRL	3	128											
ADRN	3	66	118										
ADRT	3	65	119										
AIFT	3	72											
AIFT	3	93											
ALNN	3	81	184										
ALNN	3	82	183										
ANT	16												
ARFT	3	73											
ARLT	3	94											
ARNN	3	85	186										
ARNN	3	84	185										
AX	16												
AY	16												
AZ	16												
CF1	11	38											
CF2	11	38											
CF3	11	38											
CFR1	39	47											
CFR2	39	47											
CFR3	39	47											
CFB1	39	48											
CFB2	39	48											
CFB3	39	48											
CON	107	113	114										
DAR	16												
DEFINE	133												
DP1	16	21											
EXIT	136												
EXP	107												
GROUND	15												
W1	17												
W2	17												
I	34	38	133										
IEL	15												
IFILE	26												
ILABL	1	37	33	35	36	131	133						
ILBL	24	24	29	30	131								
IPYDAT	2	8	31	134									
X	18												
LAMBDA	14	16	18										
NEL	38												
WHP	3	4	91	92									
WHP	13												

OF ILG	30												
PLST	3												
REAL	47	44											
REC	13												
RELEASE	130	135											
RT	13	39	61	71	88	81	92	101	102	107	118	124	
RTPT	3	71											
RTLT	3	92											
RTMN	3	87	102										
RTME	3	81	121										
RE	13	39	60	74	75	89	95	96	124				
REPT	3	58											
RELT	3	89											
RENN	3	74	95										
RENN	3	75	96										
RT	13	39	69	76	77	90	97	98	124				
RTPT	3	69											
RTLT	3	97											
RTMN	3	74	97										
RTME	3	71	98										
RE	13	39	70	78	79	81	90	100	124				
REPT	3	71											
RELT	3	91											
RENN	3	74	120										
RENN	3	79	99										
TO	61	107	112										
TAJ	30	107											
VAL	17												
X	10	30											
X1	19												
X2	19												
Y	10	30											
Z	10	30											
Z1	19												
Z2	19												
30	14	36											
40	92	60											
203P	30	137											
201P	30	126											
1002P	32	33	35	36	37								
2002P	24	25	70										
2001P	22	21											
2002P	27	24											
2003P	124	125											
2009P	30	41											
2004P	111	172											

APPENDIX D GLDPLT

GLDPLT,F4

F40

V27(362)

22-APR-76

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```

1      DIMENSION ITYPE(3,2)
2      DATA ITYPE/'STATI','C VAL','UES','DYNAM','IC VA','LUES'/
3      DATA PID,PRD/'C0ID','THEOD'/
4      DIMENSION SPACE(4),IAX(2,3)
5      DATA SPACE/1.,.2.,.2.5,5./
6      DATA IAX/'DEGRE','ES',' FEET',' ','SECON','OS'/
7      DATA PRX,PRY,PRZ,PRT,PAI,PAR/
8      DATA 'RX','RY','RZ','RT','C0I','THEO'/
9      DIMENSION IPTDAT(33)
10     COMMON /PTXN/NRP,RXMY,RXMX,RXFT,RXLT,RMYN,RMYX,RYFT,RYLT,
11     :RZMN,RZMX,RZFT,RZLT,RTMN,RTMX,RTFT,RTLT,
12     :ZAIMN,AIMX,AIFT,AILT,ARMN,ARMX,ARFT,ARLT,
13     :ADIN,ADIX,ADIF,ADIL,ADRN,ADRX,ADRF,ADRL
14     EQUIVALENCE (IPTDAT(1),NRP)
15     DIMENSION ILABL(8)
16     DATA XLEN,YLEN,ITIC/20.,8.,.21/
17     DIMENSION DY1(2000)
18     DIMENSION DX(2000),DY(2000)
19     NAMELIST /FREQ/ YLENG,YDEL,YSC,DMIN,DMAX,DEL,IP,XSC
20     CALL PLOTS(1BUF,360,16)
21     3      WRITE(9,1006)
22     1006  FORMAT(' INPUT FILE NAME AND AXIS TYPES:',S)
23     READ(5,1005) NAME,ISX,ISY,BOUND
24     1005  FORMAT(A5,1,I,F)
25     IF (ISY .LT. 1) GO TO 204
26     IF (ISY .GT. 2) GO TO 204
27     IF (ISX .LT. 1) GO TO 204
28     IF (ISX .GT. 3) GO TO 204
29     CALL PLOT(0.,-12.,-3)
30     CALL PLOT(0.,1.,-3)
31     I=0
32     CALL IFILE(20,NAME)
33     READ(20) IPTDAT
34     WRITE(3,1002) NRP
35     1002  FORMAT(' THERE ARE',I9,' RECEIVER POINTS',/)
36     WRITE(3,1003)
37     1003  FORMAT(14X,'MIN',9X,'MAX',9X,'FIRST',9X,'LAST',/)
38     1004  FORMAT(1X,A5,1X,4F12.4)
39     WRITE(3,1004) PRX,RXMY,RXMX,RXFT,RXLT
40     WRITE(3,1004) PRY,RMYN,RMYX,RYFT,RYLT
41     WRITE(3,1004) PRZ,RZMN,RZMX,RZFT,RZLT
42     WRITE(3,1004) PRT,RTMN,RTMX,RTFT,RTLT
43     WRITE(3,1004) PAI,AIMN,AIMX,AIFT,AILT
44     WRITE(3,1004) PAR,ARMN,ARMX,ARFT,ARLT
45     WRITE(3,1004) PID,ADIN,ADIX,ADIF,ADIL
46     WRITE(3,1004) PRD,ADRN,ADRX,ADRF,ADRL
47     GASD=0,
48     GASU=0,
49     GACN=0,
50     DO 7 I1=1,3
51     READ(20,100) ILABL
52     WRITE(3,101) ILABL
53     101  FORMAT(1X,8A5)

```

GLDPLT.F4

F40

V27(368)

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94      100  FORMAT(8A5)
95      CALL SYM90L(8.,8.,2,1,LABL,98.,40)
96      7    CALL PLOT(3,8.,-3)
97      CALL SYM90L(8.,8.,2,1,TYPE(1,15),98.,15)
98      CALL PLOT(2,8.,-3)
99      1    READ(20,1000,END=2) X,Y,Z,T,C,R,CD,RO
100     1000  FORMAT(8F)
101     TEMP=SQRT(X*X+Y*Y)
102     IF((TEMP .LT. 3500.) .OR. (TEMP .GT. 2P720.)) GO TO 60
103     GASUMGASU=C
104     GASDCGASD=CD
105     GACNUGACN=1.
106     60    CONTINUE
107     I=I+1
108     GO TO (300,301) 15V
109     300    CONTINUE
110     DY(1)=C
111     DY(1)=R
112     GO TO 302
113     301    DY(1)=CD
114     DY(1)=RO
115     302    CONTINUE
116     GO TO (200,201,202) 1SX
117     200    DX(1)=ATAN2(Z, SQRT(X*X+Y*Y))*97.2053
118     GO TO 199
119     201    DX(1)=X
120     GO TO 199
121     202    DX(1)=Y
122     GO TO 199
123     199    IF(1 .NE. 1) GO TO 198
124     DMIN=DX(1)
125     DMAX=DX(1)
126     198    DMIN=AMIN1(DMIN,DX(1))
127     DMAX=AMAX1(DMAX,DX(1))
128     1001   FORMAT(5X,3F)
129     IF(1 .LT. 2000) GO TO 1
130     2      IF(1 .LT. 2) GO TO 3
131     YLENG=AMAX1(AINX,ABS(BOUND),-AIMN,0.)
132     IF(ARS(BOUND) .LT. 1.F-4) GO TO 10
133     YDEL=YLENG
134     GO TO 11
135     10     YLENG=AMAX1(YLENG,ARMX,-ARMN)
136     YDEL=FLOAT(1/FIX(YLENG/YLEN))
137     YLENG=YDEL*YLEN
138     11     CALL AX1S3(8.,8.,-YLENG,YLENG,YDEL,YLEN,
139     1'MICROAMPERES',12,8,8.,YSC)
140     IP=IP*(ALOG10(DMAX-DMIN))-1
141     POW=18.9*IP
142     DO 120 J=1,4
143     DEL=SPACE(J)*POW
144     IT=1/FIX(DMAX/DEL-1.)+1-1/FIX(DMIN/DEL)
145     IF(IT .LT. ITIC) GO TO 121
146     120    CONTINUE

```

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```

127 121 DM=DFLOAT(1/FIX DMIN/DEL) *DEL
128 DM=DFLOAT(1/FIX(1-DMIN/DEL) *DEL)
129 IP=1
130 IF (IP .LT. 8) IP=8
131 CALL ATN3(0.,P.,DMIN,DMIN,DEL,-LEN,1001,1001,7,IP,0.,ASC)
132 CALL PLOT(0.,LEN/2.,-3)
133 CALL PLOT(LEN,0.,2)
134 WRITE(9,PRCD)
135 CALL PLOT((DM1)-DMIN/ASC,DY1/ASC,3)
136 WRITE(13,1001) DM1,DY1,DY1(1)
137 GASDGGASD=.7/GACN/150.
138 GASDGGASD=.7/GACN/150.
139 WRITE(13,1007) GASD,GASD,GACN
140 FORMAT(' STATIC MEAN ANGLE ERROR=',E.//
141 ' DYNAMIC MEAN ANGLE ERROR=',E.10X,'COUNT=',P6.0)
142 DO 4 J=2,1
143 WRITE(13,1001) DM1,DY1,DY1(1)
144 4 CALL PLOT((DM1)-DMIN/ASC,DY1/ASC,3)
145 IF (DM1) .LT. 0.1 GO TO 8
146 IP=8
147 CALL PLOT((DM1)-DMIN/ASC,DY1/ASC,3)
148 DO 6 J=2,1
149 CALL PLOT((DM1)-DMIN/ASC,DY1/ASC,3)
150 6 IP=8-15
151 8 CALL PLOT(LEN+2.,-5,-3)
152 GO TO 3
153 784 CALL PLOT(3.,0.,000)
154 CALL EXIT
155 STOP
156 ENH

```

CONSTANTS

8	000000000000	1	000000000000	2	000000000000	3	000000000000	4	000000000000
9	000000000000	5	000000000000	6	000000000000	7	000000000000	11	000000000000
12	000000000000	13	000000000000	14	000000000000	15	000000000000	16	000000000000
17	000000000000	20	000000000000	21	000000000000	22	000000000000	23	000000000000
24	000000000000	25	000000000000	26	000000000000	27	000000000000	30	000000000000
31	000000000000	32	000000000000	33	000000000000	34	000000000000	35	000000000000
36	000000000000								

COMMON

QRP	/PTXN /-0	QYH	/PTXN /-1	QYH	/PTXN /-2	QYH	/PTXN /-3	QYH	/PTXN /-4
QYH	/PTXN /-5	QYH	/PTXN /-6	QYH	/PTXN /-7	QYH	/PTXN /-8	QYH	/PTXN /-9
QYH	/PTXN /-10	QYH	/PTXN /-11	QYH	/PTXN /-12	QYH	/PTXN /-13	QYH	/PTXN /-14
QYH	/PTXN /-15	QYH	/PTXN /-16	QYH	/PTXN /-17	QYH	/PTXN /-18	QYH	/PTXN /-19
QYH	/PTXN /-20	QYH	/PTXN /-21	QYH	/PTXN /-22	QYH	/PTXN /-23	QYH	/PTXN /-24
QYH	/PTXN /-25	QYH	/PTXN /-26	QYH	/PTXN /-27	QYH	/PTXN /-28	QYH	/PTXN /-29
QYH	/PTXN /-30	QYH	/PTXN /-31	QYH	/PTXN /-32	QYH	/PTXN /-33	QYH	/PTXN /-34
QYH	/PTXN /-35	QYH	/PTXN /-36	QYH	/PTXN /-37	QYH	/PTXN /-38	QYH	/PTXN /-39

SLDPROGRAMS

GLOPLT.F4		F48	V27(362)	22-APR-76	11:04										
FORSE.	.JOFF	ALLIO.	PLOTS	ALPHO.	ALPHI.	INTO.	INTI.	FLOUT.	FLIRT.	PLOT	IFILE	SINMR.	SYMBOL	END.	
SORT	ATAN2	AMIN1	AMAX1	ABS	FLOAT	IFIX	AXIS3	ALOG1P	EXP2.2	NMLST,	EXIT				
SCALARS															
PID	1230		PRD	1231		PRX	1232		PRY	1233		PRE	1234		
PRY	1235		PAI	1236		PAR	1237		XLEN	1240		VLEN	1241		
ITIC	1242		YLENG	1243		YDEL	1244		YSC	1249		DMIN	1246		
OMAX	1247		DEL	1250		IP	1251		XSC	1252		BOUF	1253		
NAME	1254		ISX	1255		ISY	1256		BOUND	1257		I	1260		
WRP	0		RKMN	1		RKMX	2		RKFT	3		RKLT	4		
RYMN	5		RYMX	6		RYFT	7		RYLT	10		RYMN	11		
RSMX	12		RZFT	13		RZLY	14		RYMN	15		RYMX	16		
RTFT	17		RYLT	20		AIMN	21		AIMX	22		AIFT	23		
AILT	24		ARMN	25		ARMX	26		ARFT	27		ARLT	28		
ADIN	31		ADIX	32		ADIF	33		ADIL	34		ADRN	35		
ADRX	36		ADRF	37		ADRL	40		CASD	1241		CASU	1262		
SACN	1263		II	1264		X	1265		Y	1266		Z	1267		
T	1270		C	1271		R	1272		CD	1273		RD	1274		
TEMP	1275		POW	1276		J	1277		IT	1300		ISH	1301		
ARRAYS															
ITYPE	1302		SPACE	1310		IAX	1314		IPDAT	0		ILABL	1322		
OY1	1332		DX	9292		DY	11172								

J	102	103	122	123	124	128	129							
NAME	23	32												
MSP	10	14	34											
PAI	7	43												
PAR	7	44												
PID	3	45												
PLOT	20	37	96	98	112	113	119	124	127	129	131	133		
PLOTS	28													
POM	101	103												
PRO	3	46												
PRT	7	42												
PRX	7	39												
PRY	7	40												
PRZ	7	41												
PTXEN	10													
R	99	71												
RO	99	74												
RTPT	10	42												
RLT	10	42												
RYMN	10	42												
RYMX	10	42												
RYPT	10	39												
RKLT	10	39												
RKMN	10	39												
RKMX	10	39												
RYPT	10	40												
RYLT	10	42												
RYMN	10	42												
RYMX	10	40												
REPT	10	41												
RELT	10	41												
REMN	10	41												
REMX	10	41												
SPACE	4	5	103											
SORT	61	77												
SYMBOL	99	57												
T	99	81												
TEMP	61	62												
X	99	61	77	79										
XLEN	16	111	113	131										
XSC	19	111	115	124	127	129								
Y	99	61	77											
YDEL	19	93	96	97	98									
YLEN	19	96	97	98	112									
YLENG	19	91	93	95	96	97	98							
YSC	19	98	115	124	127	129								
Z	99	77												

1P	59	89							
2P	59	90							
3P	21	90	132						
4P	122	124							
5P	120	132							
7P	50	54							
8P	125	131							
10P	92	95							
11P	94	98							
60P	62	66							
100P	51	54							
101P	52	53							
122P	102	106							
121P	105	107							
100P	83	86							
199P	78	80	82	83					
202P	76	77							
201P	76	79							
202P	76	81							
204P	25	26	27	28	133				
300P	68	69							
301P	68	73							
302P	72	75							
1000P	59	60							
1001P	88	116	123						
1002P	34	35							
1003P	34	37							
1004P	38	39	40	41	42	43	44	45	46
1005P	23	24							
1006P	21	22							
1007P	119	120							

GLOPLT.F4

F48

V27(362)

22-APR-76

11:04

```

1  SUBROUTINE AXIS3(X0,Y0,AMAX,AMIN,DELA,AINCH,BCC,NCR,NDEC,PWR,DELN)
2  DIMENSION BCC(1)
3  HT = .10
4  DELA=SIGN(DELA,(AMAX-AMIN))
5  W1=0.
6  W2=0.
7  W3 = 0.
8  NEXP = 0
9  NCH=ABS(NCR)
10 IF(PWR,NE.0.) NEXP = 6
11 CINCH=ABS(AINCH)
12 IF(ABS(AMAX-AMIN)+ABS(DELA).LT.1.E-3) GO TO 38
13 IF((AMAX-AMIN)/(DELA+1.E-5).GT.3.*CINCH) DELX = (AMAX-AMIN)/CINCH
14 IF(NCR.LT.0) W3 = 1.
15 NUM=FIX((AMAX-AMIN)/DELX+1.9)
16 ANC=CINCH/FLOAT(NUM-1)
17 IF(AINCH.LT.0) GO TO 5
18 W2=1.
19 GO TO 10
20 W1=1.
21 10 CALL PLOT(X0,Y0,3)
22 DELN=DELX/10.*PWR/ANC
23 ANUM=AMIN-DELX
24 X=P.
25 Y=0.
26 XM=0.
27 DO 40 I=1,NUM
28 ANUM=ANUM+DELX
29 II=0
30 25 IF(ABS(ANUM)/10.*II.LT.1.) GO TO 27
31 II=II+1
32 GO TO 25
33 20 IF(ANUM.LT.0.) II=II+1
34 IF(ABS(ANUM).LT.1.) II=II+1
35 IMORE=NDEC+1
36 II=II+IMORE
37 IF(FIX(W1)+1.E0.1) HT = AMIN1(HT,ANC,FLOAT(II+2))
38 CENTER = FLOAT(II)*HT/(1.+W1)
39 OFF = .05
40 XC = X - CENTER + W2*(W3*(1.30+CENTER) - .15)
41 IF(XC.LT.XM) XM=XC
42 YC = Y - W1*(HT + .15 - W3*(HT+.13)) - W2*OFF
43 CALL PLOT(X0+X,Y0+Y,2)
44 CALL PLOT(X0+X+.1*W2,Y0+Y+.1*W1,3)
45 CALL PLOT(X0+X-.1*W2,Y0+Y-.1*W1,2)
46 CALL NUMBER(X0+XC,Y0+YC,HT,ANUM,0.,NDEC)
47 CALL PLOT(X0+X,Y0+Y,3)
48 X=X+ANC*W1
49 Y=Y+ANC*W2
50 40 CONTINUE
51 BST = (CINCH - FLOAT(NCH-NEXP)*.12)/2.
52 XXC = W1*(X0 + BST) + W2*(X0 + XM + OFF + W3*(2.*CENTER+.44))
53 YYC = W1*(Y0 + YC - .17 + W3*(HT + .22)) + W2*(Y0 + BST)

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GLDPLT,F4 F40 V29(36F) 22-APR-76 11:04

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34 CALL SYMBOL(XXC,VYC,.12,RCD,90,0W2,NCH)
35 IF(PWR,EO,0.) RETURN
36 CALL WHERE(XO,YO,XXC)
37 CALL SYMBOL(XO,YO,.12,5H + 10.90,0W2,9)
38 CALL WHERE(XO,YO,XXC)
39 X = YO + (XXC-.00-XO)*W2
40 Y = YO + (VYC+.00-YO)*W1
41 CALL NUMBER(X,Y,.09,PWR,90,0W2,-1)
42 RETURN
43 9F DELN = 1.E-3*10.00PWR/CINCH
44 N=NCR/5
45 WRITE(5,1000) AMAX,AMIN,DELA,PWR,(BCD(1),10L,N)
46 1000 FORMAT(1H0.27MINBUFFICIENT RANGE FOR AXIS ,
47 1/.1X,4G,/.1X,13A5)
48 CALL EXIT
49 RETURN
50 ENN

```

CONSTANTS

P	175631463146	1	167406111564	2	160517426542	3	8174631-631	4	000000000003
5	201402000070	6	174631463146	7	177463146314	10	24463146314	11	000000000002
12	000000000070	13	175753412172	14	177722436560	15	76934121727	16	176782436560
17	201244036540	20	000000000000	21	000000000005	22	75907534121	23	175940907534

GLOBAL DUMMIES

XO	696	YO	697	AMAX	660	AMIN	661	DELA	662
AINCH	663	BCD	664	NCR	665	NDEC	666	PWR	667
DELN	678								

SUBPROGRAMS

SIGN	1A05	ABS	IFIX	FLOAT	PLOT	EXP3.2	EXP2.2	AMIN1	NUMBER	SYMBOL	WHERE	ALLIO.	ALPHO.	ALPHI.
EXIT														

SCALARS

AXIS3	673	WT	674	DELX	679	DELA	662	AMAX	660
AMIN	661	W1	676	W2	677	W3	700	NEXP	701
NCH	702	NCR	665	PWR	667	CINCH	703	AINCH	663
NCH	704	ANC	705	XO	696	YO	697	DELN	678
ANUM	706	X	707	Y	710	XM	711	I	712
II	713	IMORE	714	NDEC	666	CENTER	715	OFF	716
XC	717	YC	720	OST	721	XXC	722	VYC	723
XO	724	YO	729	XXC	726	N	707		

ARRAYS

BCD	664
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[illegible]

APPENDIX E FMAKE

FMAKE.F4

F40

V27(360)

22-APR-76

11:04

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1      DIMENSION IDUM(2)
2      DATA IDUM(2)/'.DAT'/
3      COMMON XX,YY,ZZ,TT
4      DIMENSION ILABL(8)
5      DIMENSION X(20),Y(20),Z(20)
6      IMPLICIT COMPLEX (C)
7      DIMENSION C1(20),C2(20),C3(20)
8      COMMON /GROUND/ K,X1(20),Z1(20),X2(0/20),Z2(0/20),IEL
9
10     C
11     C THIS SECTION ACCEPTS THE INPUT OF THE SWITCH (ONE CHARACTER) TO
12     C DETERMINE WHAT KIND OF FILE TO GENERATE,
13     C <BLANK> TO END THE PROGRAM
14     C Y TO SET ANTENNA OFFSET AND XMISSION WAVELENGTH
15     C G FOR GROUND DESCRIPTION
16     C P FOR FLIGHT PATH
17     C A FOR ANTENNA DESCRIPTION
18     C
19     C WRITE(5,1013)
20     C READ(5,1009) NAME
21     C IF(NAME.EQ.' ') GO TO 3
22     C IF(NAME.EQ.'Y') GO TO 20
23     C IF(NAME.EQ.'G') GO TO 21
24     C IF(NAME.EQ.'P') GO TO 22
25     C IF(NAME.EQ.'A') GO TO 23
26     C WRITE(5,1012)
27     C GO TO 2
28
29     C
30     C THIS IS THE INPUT FOR THE ANTENNA OFFSET AND FOR THE
31     C TRANSMISSION WAVELENGTH, BOTH ARE IN FEET AND ARE FLOATING POINT.
32     C
33     C WRITE(5,1011)
34     C READ(5,101) Y0,RL
35     C GO TO 2
36
37     C
38     C THIS SECTION IS FOR GROUND DESCRIPTION
39     C
40     C WRITE(5,1014)
41     C
42     C THIS IS TO INPUT THE FILE NAME FOR GROUND DESCRIPTION
43     C
44     C READ(5,105) IDUM(1)
45     C WRITE(5,104)
46     C
47     C THIS IS TO INPUT THE PLOT LABEL FOR GROUND DESCRIPTION
48     C
49     C READ(5,105) ILABL
50     C WRITE(5,100)
51     C
52     C THIS IS THE INPUT FOR THE GROUND STRIP EDGE COORDINATES
53     C
54     C R DELTA X-COORDINATE FOR CARTESIAN AND
55     C RANGE FOR POLAR COORDINATES
56     C ZZ DELTA Y-COORDINATE FOR CARTESIAN AND
57     C USUALLY ZERO FOR POLAR COORDINATES
58     C THETA ZERO FOR CARTESIAN COORDINATES AND
59     C THE ELEVATION ANGLE FOR POLAR
60     C
61     C THIS IS THE INPUT FOR THE STARTING EDGE OF THE FIRST STRIP
62     C READ(5,101,END=2) R,ZZ,THETA
63     C X2(0)=R*COSD(THETA)-ZZ*SIND(THETA)

```

FNAKE.F4

F4B

V27(36B)

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94      ZZ(8)=R*SIND(THETA)+ZZ*COSD(THETA)
95      K=8
96      WRITE(5,102)
97      C
98      C THIS IS THE INPUT LOOP FOR THE REST OF THE STRIP EDGES. THE
99      C EDGES ARE THE TRAILLINE EDGE OF THE PREVIOUS STRIP AND THE
60      C LEADING EDGE OF THE NEXT. THE LOOP WILL CONTINUE TO A MAXIMUM OF
61      C TWENTY STRIPS OR UNTIL BOTH 'R' AND 'ZZ' ARE ZERO.
62      11 READ(5,101,END=2) R,ZZ,THETA
63      IF(R.NE.0.) GO TO 5
64      IF(ZZ.NE.0.) GO TO 5
65      IF(K.EQ.20) GO TO 2
66      GO TO 4
67      5 K=K+1
68      X1(K)=X2(K-1)
69      Z1(K)=Z2(K-1)
70      X2(K)=X2(K-1)+R*COSD(THETA)-ZZ*SIND(THETA)
71      Z2(K)=Z2(K-1)+R*SIND(THETA)+ZZ*COSD(THETA)
72      IF(K.LT.20) GO TO 6
73      WRITE(5,103)
74      GO TO 4
75      6 WRITE(5,102)
76      GO TO 11
77      C
78      C THIS OPENS A FILE FOR THE GROUND DESCRIPTION, OUTPUTS IT
79      C IN BINARY AND CLOSES THE FILE. FLOW THEN RETURNS TO THE SWITCH POINT.
80      4 CALL OFILE(20,IDUM(1))
81      WRITE(20,105) ILABL
82      WRITE(20) K,X1,Z1,X2,Z2
83      CALL RELEAS(20)
84      GO TO 2
85      C
86      C THIS IS THE SECTION TO GENERATE A FLIGHT PATH FILE.
87      22 WRITE(5,1015)
88      C
89      C THIS INPUTS THE FLIGHT PATH FILE NAME
90      READ(5,105) IDUM(1)
91      C
92      C THIS IS TO CREATE THE FILE IF ONE DOES NOT ALREADY EXIST.
93      C THIS IS NECESSARY AS JOVRAX DOES NOT CREATE FILES.
94      CALL OFILE (20,IDUM(1))
95      CALL RELEAS(20)
96      C
97      C THIS IS TO OPEN THE FILE FOR JOVRAX
98      CALL JOVSET(1,IDUM(1),NSIZE)
99      WRITE(5,1003)
100      C
101      C THIS IS TO INPUT THE FLIGHT PATH PLOT LABEL AND OUTPUT IT TO
102      C THE FILE
103
104      READ(5,105) ILABL
105      CALL JOVNO(1,ILABL,8,8)
106      WRITE(5,1008)

```

EMANE.F4 F40 V27(368) 22-APR-76 11134

```

187 C
188 C THIS SWITCH IS TO SELECT EITHER STRIGHT LINE FLIGHT OR
189 C HYPERBOLIC. 'G' INPUT WILL SELECT HYPERBOLIC ANYTHING ELSE WILL
190 C GIVE STRIGHT LINE.
191 READ(9,1000) I
192 IF(I .NE. 'G') GO TO 12
193 C
194 C THIS IS THE HYPERBOLIC FLIGHT SECTION
195 WRITE(9,1010)
196 C
197 C THIS IS THE INPUT TO DESCRIBE THE FLIGHT
198 C X0 STARTING X-COORDINATE
199 C X1 ENDING X-COORDINATE
200 C H HEIGHT OF MAIN ELEMENT USED TO DETERMINE GLIDE ANGLE
201 C AND HEIGHT ABOVE GROUND OF ZERO CDI SURFACE AT CLOSEST
202 C APPROACH
203 READ(9,1011) X0,X1,H
204 WRITE(9,1004)
205 C
206 C THIS INPUT IS FOR THE FLIGHT PATH QUANTIZATION PARAMETERS
207 C NK IS THE NUMBER OF POINTS ALONG THE FLIGHT PATH
208 C V IS THE VELOCITY (FT./SEC.) OF THE AIRCRAFT
209 C TAU IS THE TIME CONSTANT (SEC.) FOR THE DYNAMIC CDI
210 READ(9,1007) NK,V,TAU
211 IF(NK .LE. 0) GO TO 22
212 CALL JOVMD(1,TAU,1,0)
213 C
214 C THIS LOOP GENERATES THE COORDINATES OF THE POINTS ALONG THE
215 C HYPERBOLA AND OUTPUTS THEM TO THE FLIGHT PATH FILE
216 A1=RL*RL*.25-H*H-Y0*Y0
217 A2=1./((1.-4.*H*H/RL/RL)
218 DX=(X1-X0)/FLOAT(NK-1)
219 XX=X0
220 YY=Y0
221 TT=T0
222 XOL=XX
223 ZOL=SQRT((A1-XX*XX)*A2)
224 DO 13 I=1,NK
225 Z2=SQRT((A1-XX*XX)*A2)
226 TEMP=XX-XOL
227 TEMP2=Z2-ZOL
228 TT=TT+SQRT(TEMP*TEMP-TEMP2*TEMP2)/V
229 CALL JOVMD(1,XX,4,F)
230 XOL=XX
231 ZOL=Z2
232 XX=XX+DX
233 CONTINUE
234 GO TO 14
235 C
236 C THIS SECTION IS FOR STRIGHT LINE FLIGHT
237 CONTINUE
238 WRITE(9,1004)
239 C

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FMARE.F4 F48 V27(368) 22-APR-76 11184

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160 C THESE INPUTS ARE TO DESCRIBE THE FLIGHT PATH
161 C XX STARTING X-COORDINATE (FEET)
162 C YY STARTING Y-COORDINATE (FEET)
163 C ZZ STARTING Z-COORDINATE (FEET)
164 C XF ENDING X-COORDINATE (FEET)
165 C YF ENDING Y-COORDINATE (FEET)
166 C ZF ENDING Z-COORDINATE
167 C NK NUMBER OF POINTS ALONG THE FLIGHT PATH
168 C V VELOCITY OF AIRCRAFT (FEET/SEC.)
169 C TAU TIME CONTANT FOR DYNAMIC CDI (SEC)
170 READ(5,101) XX,YY,ZZ
171 WRITE(5,1005)
172 READ(5,101) XF,YF,ZF
173 WRITE(5,1006)
174 READ(5,1007) NK,V,TAU
175 IF( NK .LE. 0) GO TO 22
176 CALL JOVHO(1,TAU,1,0)
177 FN=NK-1
178 DX=(XF-XX)/FN
179 DY=(YF-YY)/FN
180 DZ=(ZF-ZZ)/FN
181 DT=SQRT(DX*DX+DY*DY+DZ*DZ)/V
182 TT=0.
183 C
184 C LOOP TO GENERATE X-,Y-, AND Z-COORDINATES AND OUTPUT THEM
185 C TO THE FLIGHT PATH FILE
186 DO 1 I=1,NK
187 CALL JOVHO(1,XX,4,0)
188 XX=XX+DX
189 YY=YY+DY
190 ZZ=ZZ+DZ
191 TT=TT+DT
192 C
193 C THIS CLOSSES THE FLIGHT PATH FILE AND RETURNS TO SWITCH POINT
194 CALL JOVREL(1)
195 GO TO 2
196 C
197 C THIS SECTION IS TO GENERATE ANTENNA DESCRIPTION FILE
198 N=0
199 WRITE(5,1007)
200 C
201 C INPUT FOR ANTENNA FILE NAME
202 READ(5,2000) ILBL
203 WRITE(5,1008)
204 C
205 C INPUT FOR ANTENNA PLOT LABEL
206 READ(5,105) ILABL
207 N=1
208 C
209 C THIS IS THE INPUT FOR ELEMENT DESCRIPTION
210 C X(I) X-COORDINATE OF I'TH ELEMENT (FEET)
211 C Z(I) Z-COORDINATE OF I'TH ELEMENT (FEET)
212 C C1(I) COMPLEX AMPLITUDE OF CARRIER COMPONENT OF I'TH ELEMENT

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FNAKE.F4

F40

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213 C      C2(1)  COMPLEX AMPLITUDE OF 150 HZ SIDEBAND OF 1' TH ELEMENT
214 C      C3(1)  COMPLEX AMPLITUDE OF 90 HZ SIDEBAND OF 1' TH ELEMENT
215 C THE PROGRAM WILL LOOP THRU 10 FOR ADDITIONAL ELEMENTS UNTIL A
216 C      ZERO IS ENCOUNTERED FOR Z(N)
217      WRITE(9,1017)
218 10 READ(5,2001) X(N),Z(N),C1(N),C2(N),C3(N)
219      IF( Z(N) .EQ. 0) GO TO 9
220 C
221 C      THIS SECTION DETERMINES THE Y OFFSET OF EACH ELEMENT. THIS
222 C IS NOMINALLY Y0 BUT THERE IS A SMALL CHANGE (LESS THEN ONE WAVELENGTH)
223 C FOR NEAR FIELD CORRECTION PURPOSES
224      SW=SIGN(1.,Z(N)-Z(1))
225      IF(N .NE. 1) GO TO 15
226      Y(1)=Y0
227      F=SQRT(Y0*Y0+Z(1)*Z(1))
228      GO TO 16
229 15 X0=Y0-SQRT(F*F-Z(N)*Z(N))
230      IF(X0=SW .LT. 0.) GO TO 17
231 10 XP=Y0-SQRT((F+RL)*(F+RL)-Z(N)*Z(N))
232      IF(XP=SW .LT. 0.) GO TO 18
233      F=F+RL*SW
234      X0=XP
235      GO TO 19
236 17 F=F-RL*SW
237      GO TO 15
238 18 Y(N)=Y0-X0
239 16 CONTINUE
240      N=N+1
241      GO TO 10
242 C
243 C      THIS SECTION OUTPUTS THE ANTENNA DESCRIPTION TO THE FILE
244 C AND ON THE LINE PRINTER. CLOSES THE FILE AND RETURNS TO THE SWITCH
245 C POINT
246 9      NEL=N-1
247      CALL OFILE(20,1LRL)
248      WRITE(20,105) 1LRL
249      WRITE(20) RL,NEL,(X(1),Y(1),Z(1),C1(1),C2(1),C3(1),I=1,NEL)
250      WRITE(3,1016) 1LRL
251      WRITE(3,2001) (X(1),Y(1),Z(1),C1(1),C2(1),C3(1),I=1,NEL)
252      CALL RELEAS(20)
253      GO TO 2
254 C
255 C      THIS IS THE PROGRAM TERMINATION POINT
256 3      CALL EXIT
257      STOP
258 1012 FORMAT(' UNKNOWN SWITCH,')
259 1013 FORMAT(' INPUT SWITCH:',S)
260 1014 FORMAT(' INPUT GROUND FILE NAME:',S)
261 1015 FORMAT(' INPUT FLIGHT PATH FILE NAME:',S)
262 1017 FORMAT(' INPUT ELEMENT VALUES.,/,)
263 1016 FORMAT(2X,0A5)
264 104  FORMAT(' INPUT GROUND LABEL',/)
265 105  FORMAT(8A5)

```

NAME.F4 F40 V27(36P) 22-APR-76 11:04

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266 100 FORMAT(' INPUT GROUND SEGMENTS. STARTING FROM ANTENNA.'//,
267 1' GIVE CONSECUTIVELY EITHER X AND Z INCREMENTS, OR THE'//,
268 2' LENGTH AND ANGLE FROM HORIZONTAL IN DEGREES, SEPARATED'//,
269 3' BY A ZERO. HIT CARRIAGE RETURN FOR END OF DATA.'//,
270 4' OR IF THERE ARE NO MORE STRIPS.'//, ' 0',S)
271 101 FORMAT(3F)
272 103 FORMAT(' ONLY 20 GROUND SEGMENTS ALLOWED. COMPUTATION WILL'//,
273 1' PROCEED WITH DATA ALREADY OBTAINED.'//)
274 102 FORMAT(' 0',S)
275 1003 FORMAT(' INPUT FLIGHT PATH TITLE'//)
276 1000 FORMAT(' INPUT FLIGHT PATH TYPE'//,S)
277 1000 FORMAT(1A1)
278 1010 FORMAT(' INPUT XP,XF,M1'//,S)
279 1011 FORMAT(' INPUT YS,LAMBDA1'//,S)
280 1004 FORMAT(' INPUT XO,YO,201'//,S)
281 1005 FORMAT(' INPUT XF,YF,2F1'//,S)
282 1006 FORMAT(' INPUT # OF PRINTS, VELOCITY, TIME CONSTANT'//,S)
283 1007 FORMAT(1,2F)
284 107 FORMAT(' INPUT ANTENNA FILE NAME'//,S)
285 2000 FORMAT(1A5)
286 100 FORMAT(' INPUT ANTENNA DESCRIPTION'//,S)
287 2001 FORMAT(0F)
288 END

```

CONSTANTS

P	20100402P10	1	94900402010P	7	435004020100	3	501004020100	4	405004020100
S	000000000024	6	000000000024	7	000000000010	10	000000000000	11	000000000004
12	201000000000								

COMMON

XX	/,COMMON/+P	YY	/,COMMON/+1	ZZ	/,COMMON/+2	TT	/,COMMON/+3	KK	/GROUND/+0
XX	/GROUND/+1	ZZ	/GROUND/+25	XX	/GROUND/+51	ZZ	/GROUND/+76	IEL	/GROUND/+123

SUBPROGRAMS

FORSE.	JOFF	END.	COSD	SIND	OF,LE	01NMR.	RELEAS	JOVSET	JOVNO	FLOAT	SORT	JOVREL	SIGN	EXIT
ALPHO.	ALPHI.	FLAUT.	FLIRT.	INTO.	INTI.									

SCALARS

NAME	1410	Y0	1411	PL	1412	R	1413	22	2
THETA	1414	K	P	SIZE	1415	I	1416	NO	1417
YF	1420	M	1421	VE	1422	V	1423	TAU	1424
AI	1425	A2	1426	2X	1427	XX	0	YY	1
YT	3	XOL	1432	ZOL	1433	TEMP	1430	TEMP2	1433
YF	1434	2F	1435	FM	1436	DY	1437	DE	1440
OT	1441	N	1442	1L0L	1443	SN	1444	F	1445
XP	1446	NEL	1447	IEL	123				

ARRAYS

	FNAME.F4	F48	V27(36B)	22-APR-76	11104	X C3	1462 1976	V X1	1506 1	Z Z1	1932 29
	TOUN	1498		ILABL	1452						
	C1	1596		C2	1626						
	K2	91		22	76						
A1	136	143	145								
A2	137	143	145								
C1	7	218	249	251							
C2	7	216	249	251							
C3	7	216	249	251							
COOD	93	94	70	71							
DY	101	191									
DX	130	192	178	181	188						
DY	172	181	189								
DZ	180	181	190								
EKIT	296										
F	227	229	231	233	236						
FLOAT	130										
FN	177	178	179	190							
GROUND	0										
H	123	136	137								
I	111	112	144	186	249	251					
JOUN	1	2	37	88	98	94					
LCL	0										
LABL	4	41	81	184	185	286	240	258			
LIBL	282	247									
JOVREL	194										
JOVBET	98										
JOVNO	105	132	149	176	187						
K	0	95	65	67	68	69	78	71	82		
M	198	207	210	219	224	225	229	231	238	248	246
NAMK	18	19	28	21	22	23					
NEL	246	249	251								
NNH	130	131	138	144	174	175	177	188			
NRIZP	90										
OFILE	00	94	247								
R	92	93	94	62	63	78	71				
RELEASE	13	95	252								
RL	30	136	137	231	233	236	249				
SIGN	224										
SIND	53	94	78	71							
SGRT	143	145	148	181	227	229	231				
SW	224	230	232	233	236						
TAN	138	132	174								
TEMP	146	148									
TEMP2	147	148									
TNETA	92	93	94	62	78	71					
TY	3	141	148	182	191						
V	130	148	174	181							
- X -	9	210	249	251							
XG	123	130	139	229	230	234	238				
X1	0	68	82								
X2	0	93	68	78	82						
XF	123	130	172	178							
XOL	142	146	198								
XP	231	232	234								
XX	3	139	142	143	145	146	149	198	192	178	187
Y	9	226	238	249	251						

[illegible]